Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

Published by McGraw Publishing Company, Inc.

Volume 71 NEW YORK, SATURDAY, APRIL 3, 1915 Number 14

Unit for Maintenance Cost

HIGHWAY engineers need not be told that the practice of figuring maintenance costs on a square yard basis is unsatisfactory, for it takes no account of the traffic which the surfacing has borne. The ton-mileage system offers a correct basis, but so far as this journal knows has been applied only to a very limited extent in this country. Once the principle is clearly understood the data and computations needed are apparent. Realizing the unsatisfactoriness of the former maintenance-cost system the Office of Public Roads has used the ton-mileage basis on the Rockville Pike experimental section and the details of the data obtained, the tabulations made and the computations for the final figures are given in an article by Messrs. James and Reeve on page 418 of this issue. Highway engineers the country over will find the discussion of much interest.

Calling the Spade

IF clippings from Iowa papers are to be trusted, there is an excellent chance that in that State shortly a spade will be called a spade and that the offering by material men of commissions to engineers who will recommend their products will be termed what it really is—bribery. It appears that there have come into the hands of the State Highway Commission letters received by various county engineers from dealers, principally in piling and timber, offering them commissions on material purchased by supervisors on their recommendation. The letters are to be offered to the proper grand juries by the State's legal officers, the deputy attorney-general considering that the offer of commissions to influence the acts of the engineers constitutes an attempt to bribe. We wish the attorney-general of Iowa every success in his efforts. Nothing would help so much to kill this highly objectionable practice as to bring it under the bribery statute.

Efficiency Through Long Service

"MOST of the principal engineers and assistants have been in the service of the Commonwealth for over 10 years." This sentence from Colonel Sohier's report on the work of the Massachusetts Highway Commission for 1914 could well be made the text of a sermon on efficient organization for road-building. It may explain, in part at least, why Massachusetts roads are held in such high regard by engineers throughout the country. They are, first of all, the product of a stable organization and a definite, continued policy. One of the common curses of State work and city work is the change in the engineering personnel which politicians are able to control in some localities. No State highway system can ever be developed to its limit of effectiveness if the planning of routes and the actual building of the roads are turned over to new men, periodically, in payment for political debts. It is expensive to educate highway engineers. In the art of road-building, particularly, long experience is needed for effective work. When the novice eventually "finds himself," his value is incalculable and under no circumstances should he be replaced just when he is in a position to repay the State for the years of training which it has given him. Every executive realizes the value of the seasoned man and strives to retain his services. Massachusetts has thoroughly learned this important lesson, with the result that she can put all of her funds into the roads, instead of into the education of engineers, certain to depart very shortly for other fields.

Asphalt Block Pavements

OBJECTION has been made to the statement in this journal of Feb. 13, page 203, that asphalt block pavement has "been eliminated from among the standards for the Borough of Manhattan," New York City, said statement being taken from a report of the former chief engineer of the Bureau of Highways of that borough. The statement is declared false, first, because the Board of Estimate has designated asphalt block as both a "permanent" and "preliminary" pavement for the whole city of New York, and, second, because the same board this year refused to accept a recommendation adverse to asphalt block and authorized the pavement to be used. Asphalt block may be used, either for original paving, on petition of the property owner to which class of work the resolutions of the Board of Estimate above cited alone apply, or for repaving, at the volition of the Bureau of Highways, though the amount used in Manhattan has, in pursuance of the policy of the bureau under Mr. Durham's regime, been gradually decreased. The Engineering Record has been informed that the policy of the new administration of the bureau as to asphalt block differs from that of its predecessor, in so far that asphalt block is considered a standard pavement and that standard specifications therefor will be prepared.

Screw Spikes Prove Satisfactory

INASMUCH as railroad engineers are not as yet of one mind as to the value of screw versus cut spikes, the observations of G. J. Ray, chief engineer of the Delaware, Lackawanna & Western Railroad, after a five-year trial of screw spikes, should interest all railroad men—for the cut spike certainly leaves much to be desired. Space limitations do not permit the reproduction in its entirety of Mr. Ray's paper, which appears in the "Bulletin" of the American Railway Engineering Association. The abstract on page 430, however, quotes some of his general observations, by which it is seen that some of the difficulties anticipated have never materialized, that on the other hand the screw-spike has in several respects proved more effective than the cut spike, and that the Lackawanna has no doubt of the ultimate success of its undertaking. Mr. Ray's forty summarized conclusions cover not only the spikes, but also the holes therefor and the ties and tieplates, and include precautions to be observed in the use of screw spikes. Those who are inclined to condemn the innovation should consider whether these precautions have not been violated. Some will contend that under the densest traffic the difficulties can not be overcome, but few roads need worry on that score if the newcomer can endure the traffic of the main line of the Lackawanna.

Legislators Need Road Instruction

ROAD schools for town and county officials, being held in increasing number in all parts of the United States, have had such a good effect in spreading sound doctrine on construction and maintenance that a broadening of their scope would be highly desirable. Why not a road school for legislators? Rhode Island might be a good place to inaugurate such instruction. Here the Legislature is in the habit of passing upon the appropriations for road construction in May of each year. No worse time could be selected, for the chief engineer of the State Board of Public Roads must wait until the construction season is a couple of months old before he can know with certainty what work he will have to do. Then everything must be rushed through to take advantage of the remaining time before cold weather comes. As a matter of fact the Rhode Island Legislature, in its wisdom, made no appropriation at all for new work last year, although a limited amount of money for maintenance was available from automobile licenses. This is false economy. The State has many miles of excellent bituminous roads and needs others. It must resurface the older routes from time to time. By delaying action on the appropriations until work everywhere else is already well advanced the Legislature imposes a heavy handicap on the State's highway department. Bids are sure to be higher when contractors are already loaded with a comfortable amount of work, while the class of contractors may not be of as high a grade as if the contracts were placed earlier. The number of bidders will also be less. It is time for Rhode Island to handle its road-building on a more reasonable basis.

Let the Careless Pay

COMMENTING upon the suit brought by the Fire Commissioner of New York against the Greenwood Cemetery Company for recovery of the cost of putting out a fire in a building where the orders of the Fire Prevention Bureau had not been obeyed, the Engineering Record expressed the view that engineers could aid in bringing home to owners their responsibility in safeguarding against spread of fire. The case in question has attracted widespread attention, and now, with it as a text, the National Fire Protection Association has issued a twenty-four page pamphlet entitled, "Individual Liability for Fires Due to Carelessness or Neglect." It strongly recommends that State laws be passed making those responsible for fires liable for damage to their neighbor's property, and for the costs of extinguishing the blaze. The association points out that for twenty years it has been laboring to reduce the easily preventable fire waste and that for five years it has had the active cooperation of national organizations of engineers, architects and manufacturers. Despite this propaganda the results are disappointing. Engineering standards bearing on every phase of fire protection and fire prevention have been prepared and, in a form suited to popular comprehension, have been freely distributed. Nevertheless, the public remains indifferent. These means, then, having failed the association now proposes that the State touch the "pocket nerve" by making every owner responsible for the fire losses which his neglect may entail upon his neighbor. The principle is sound and it is hoped that the New York case, still in litigation, will be decided in favor of the city by the ultimate court and that the decision may stimulate other States to pass similar laws.

Comprehensive Planning

RECENTLY this journal published comments on a paper by Professor Swain, the import of which was that the engineer needs to take a wider outlook, to get away from the narrowing details involved in the mathematics of design, and see his problems in a broader light. Preliminary investigations into almost every important engineering subject and the consideration of alternative solutions have a tendency to give this broadness of vision, but probably no engineering problem requires a broader outlook, a consideration of more varied factors and better judgment than the laying out of urban transit facilities. Much, therefore, that is presented in the abstract on page 427 of the report of Barclay Parsons & Klapp on the transit needs of Detroit may to some seem to be outside of the province of the engineer. Nevertheless, the various factors are all elements in a large engineering enterprise. A perusal of the full report would show still more strikingly the many sidedness of the problem—the study of each route in order that it may be changed to minimize conflict with others; differences in transit needs of transient and habitual travelers; analysis of the probable business of a subway, the transfer arrangements of feeding lines and the division of return; and, finally, broad questions of public policy, such as the justification of the expenditure by the city of money that will not earn interest in order to preserve good and ameliorate bad conditions in the distribution of its residential population. It is not given to all to engage in work of so broadening a character and, in fact, such work requires special fitness and aptitude. Nevertheless, it is of a type offering large opportunities for those with the necessary native qualities who will prepare themselves for it. The same broad planning, though with fewer and less complicated factors, is needed in the preliminary investigation for other engineering enterprises. Far more important than the results obtained by slide rule and formula or the success of a new type of subway construction, are the adequacy of the system and its details for the operating requirements and the needs of the population and, above all, the ability of the enterprise to maintain and amortize itself and produce a proper return on the investment.

Compression Formulas for Metal Columns

FROM the preliminary draft of that part of the revised building code of the city of New York which relates to working stresses, it appears that the proposed changes, insofar as metal columns are concerned, involve the elimination of reference to wrought-iron columns, a substantial reduction in the working stresses for cast-iron columns, with no changes in those for steel columns. The proposed adherence to straight-line formulas, in connection with the working stresses for both steel and cast-iron columns, is commendable, and affords an example which may wisely be followed by the building departments of other municipalities, and, in fact, by structural engineers in general.

Before commenting on the values of the proposed constants in these straight-line formulas, the occasion seems opportune for presenting—at the risk of threshing over some old straw—certain phases of the compression formula question in their strictly practical aspects. In an engineering, as distinguished from a purely theoretic sense, it would be a desirable step forward if an end were made of the multiplicity of compression formulas now in use, by recognizing, as has been done in some of the best recent specifications, first, that a constant working stress may properly be prescribed for slenderness ratios up to a certain limit, and second, that beyond this limit, and within the range of slenderness ratios allowable in practice, the straight-line formula may appropriately be given preference to any other.

The arguments in support of this position may be set forth as follows:

Short Columns.—The fact is well established that a short column, consisting of a single rolled shape, or a riveted assemblage of plates and shapes, is apt to fail initially by local buckling rather than by bending as an integral whole. The limiting slenderness ratio for failure of this character may be placed roughly at from 25 to 40, its value in any given case depending on various influences, but chiefly on the degree to which the metal throughout the cross-section derives lateral rigidity from its own thickness or from the support of adjacent parts. Rolled or built sections should be so designed that local buckling will not occur in short columns until loads well above the elastic limit are reached, and that it shall not be the initial cause of failure of long columns. For all practical purposes, therefore, the elastic limit of the material may be regarded as the life limit of short columns. For that reason, and because there is no known relation, in theory or experiment, between the slenderness ratio and ultimate strength of a short column, the practice of prescribing a constant working stress for slenderness ratios up to 30 or 40 is entirely logical.

In the specifications of the American Railway Engineering Association this limit is conservatively fixed at 29, through the provision of a maximum limit of 14,000 lb. per square inch in the application of the straight-line formula $16,000 - 70l/r$. In these specifications the chief principles governing the design of the cross-section are, first, that the thickness of web plates shall not be less than one-thirtieth of the distance between its connection with the flanges, and second, that the ratio of width to thickness of outstanding flanges shall not exceed 12. In some specifications considerably higher values are assigned to these two ratios. The first has its origin in Hodgkinson's tests of 4 and 8⅜-in. square tubular sections, dating back to the middle of the last century. Comprehensive tests for establishing both ratios are much needed. It is to be hoped that these features will receive due attention in the experimental investigation of the properties of steel columns now in progress at the Bureau of Standards under the joint auspices of the American Society of Civil Engineers and the American Railway Engineering Association.

It is important to recognize, in that connection, that the proper limiting ratios to prevent premature local buckling may be expected to be considerably lower for alloy steels than for structural carbon steels, since the former possess much higher elastic limits for the same moduli of elasticity. In the absence of tests these limiting ratios for alloy steels are purely conjectural. In view of the rapidly increasing use of alloy steels, it is highly desirable that these limits should be authoritatively established.

Long Columns.—For main compression members the maximum permissible slenderness ratio is commonly fixed at 100, and rarely above 120, the latter being the upper limit in the building code of New York

City. For a range of slenderness ratios, beginning at 30 or 40 and running up to 100 or 120, the straight-line compression formula is preferable to every other type and deserves to come into universal use on sheer merit, first because it is of the simplest form, and second, because it yields as close an average agreement with any recorded experimental values as any other formula. The claim that the Rankine-Gordon formula is rational, and, therefore, superior to the empiric straight-line formula is not only fallacious, but, within the above range of slenderness ratios, that formula represented graphically is practically coincident with a straight line, nor is there any inherent reason why the slight differences should be interpreted in favor of the Rankine-Gordon formula. Moreover, these differences are utterly insignificant in relation to the influence of such unavoidable factors as differences in end conditions, slight but unavoidable eccentricity of loading, initial stresses in rolling and riveting, variations in the moduli of elasticity, departures from perfect alignment, etc.

The only rational formula for columns is Euler's, and, for familiar reasons, that is applicable only to ratios of slenderness far beyond the above mentioned limits.

Very Long Columns.—For wind bracing and subsidiary members not subject to live loading, the permissible limit of slenderness ratios is sometimes extended to 150 or 200. In fact, in the design of metal towers for electric transmission lines the limit has at times been carried to 300 or more. The propriety of using a higher limit than 200 under any circumstances may well be questioned, but even up to that limit no single set of constants in the straight-line formula would probably meet the requirements satisfactorily for the entire range from 30 to 200. In that case, recourse may readily be had to a second set of constants for slenderness ratios from 100 or 120 to 200. Graphically, the field would then be covered by a segmental line with straight elements, of which the first would be horizontal, and the other two inclined, the third having a smaller inclination with the horizontal axis than the second.

Constants for Stright-Line Formulas.—The selection of a basic value for working stresses in steel columns may be approached in the following manner: The working stress in tension, after the live-load stresses have been increased for impact, may be placed at about one-fourth the ultimate strength, or one-half the elastic limit of the material. The basic value for compression formulas, that is to say, the constant working stress for slenderness ratios up to 30, should be somewhat lower than the working stress in tension, and it may be doubted that this ratio should be allowed to exceed eight-tenths. For a tensile working stress of 16,000, this would mean a maximum working stress of, say 13,000 in compression. In the A. R. E. A. specifications the maximum working stress is placed at 14,000. In the specifications of the Department of Bridges, of New York City, the first constant in the straight-line formula is 12,000, and in the building code of New York City, 15,200. For $l/r = 30$, the working stresses from these formulas are 11,100 and 13,500 respectively.

Concerning the value of the second constant in the straight-line formula, there is much more room for legitimate difference of opinion, owing to the absence of comprehensive test data. This accounts for such values as 70, 30 and 58, respectively, in the three specifications just mentioned. It would seem, however, that until more extensive and reliable data are available, the A. R. E. A. formula may well be adopted in the revision of the building code, but with a maximum working stress of 13,000 instead of 14,000 lb. per square inch.

Cast-Iron Columns.—In the present building code, the formula for cast-iron columns is $11{,}300 - 30\ l/r$. In the proposed revision the formula is $9{,}000 - 40l/r$. The maximum slenderness ratio is 70 in both cases. The ultimate strength of cast-iron columns, according to the Watertown Arsenal tests of 1887-8, is represented conservatively by the formula $34{,}000 - 88\ l/r$, but the tests made at Phoenixville in 1897, after the failure of the Ireland building, indicated that the values by this formula are on the average too high by about 8 per cent, and that they are more closely represented by the formula $31{,}000 - 80l/r$. With a safety factor of 4, this would lead to the formula $8{,}000 - 20\ l/r$ for working stresses. The values by this formula, in comparison with that in the proposed revision of the building code, would be somewhat lower for the smaller length ratios, and somewhat higher for the larger ratios.

The proposed reduction in the present working stresses for cast-iron columns is doubtless in the right direction, although it may be questioned whether, in view of the unreliable character of the material in comparison with steel, a further reduction of at least 10 per cent would not be amply warranted.

Tendencies in Submarine Design

ENGINEERS the world over are watching with intense interest the work of submarines in the European war, for never before has there been so large an opportunity to try out various designs of this type of craft. If the present censorship continues it will be necessary to wait until the termination of hostilities before the merits of specific types of submersible boats are made public. Then, indeed, technical literature will be enriched in many ways not now possible, but in the meantime much may be said about submarines as developed through long and arduous experimentation, and tendencies in their design may be examined in a general way. The limitations of these craft are but little appreciated by the public.

One of the most exhaustive discussions of the development and status of the submarine boat which has been given to the public since the outbreak of the war was contributed in a recent lecture before the Society of Arts at Boston by Prof. William Hovgaard of the Massachusetts Institute of Technology. Contrary to popular ideas, the conception of submarine navigation is an old one and boats of this kind have been built and operated fairly successfully several times during the last 140 yr., the original development, in fact, going back to the seventeenth century. Like many other devices, the submarine is the work of many men extending over long periods, and even to-day it is a long way from anything like complete standardization.

It is practically impossible, even to-day, to write specifications for a "standard" submarine, and it goes without saying that every month's experience at present is proving immensely instructive to naval engineers charged with the design and handling of these weapons. From small early sizes they have been developed to maximum displacements of 1000 to 1200 tons; the surface speed has risen to 20 knots in the latest types laid down, and a submerged speed of 11 knots practically doubles the under-water effectiveness of the craft of only a few years ago, or will do so as soon as the latest designs of which anything is known can go into service. The problems of securing proper buoyancy, quick control of submergence, accurate steering and observation, larger cruising radius, anything beyond barely endurable working conditions for crews, and the slightest measure of self-defence against bomb-dropping sea planes and torpedo boats equipped with rapid-fire guns are difficult beyond the layman's conception.

Some of the best thought of the naval engineering profession is now being devoted to the possibility of unifying the motive power of the submarine, doing away with the oil engine and the battery-driven electric motor, and perhaps substituting an ordinary boiler with oil fuel for the surface and the so-called secondary "soda boiler" when operating below. Whether the steam turbine will drive the internal combustion engine and the electric motor out of the submarine field cannot be definitely answered today in view of the weight, space and chemical difficulties of proposed substitutes, but the work of the next few years will be full of interest in this connection. Many changes are afoot in submarine design, notably the more minute subdivision of the hull to withstand the maximum water pressure likely to be encountered; the modification of the cross-sectional shape to secure different results in the way of stability, handling, fuel and air storage; the perfection of signalling apparatus for use under water; increased power of offensive; arrangements permitting mine-laying; equipment with light armor and with light guns in disappearing mountings; the use of two and three propellers and the refinement of trim and directional control. Like the modern air-craft, the submarine is immensely valuable within its limitations, but a vast amount of constructive work is still necessary before this interesting naval auxiliary can seriously threaten the command of the ocean by the most powerful battleships, dangerous though it is in the more confined waters of seas in fairly close touch with its base.

Maintenance Cost System Used on U. S. Experimental Road

Ton-Mileage Basis Adopted as More Satisfactory Than Square-Yard Unit—Comparison of American and European Traffic Coefficients

By E. W. JAMES and C. S. REEVE
Chief of Maintenance Chemist
Office of Public Roads, Washington

THE MAINTENANCE of the experimental road built in 1913 by the U. S. Office of Public Roads on the Rockville Pike near Washington has provided an excellent opportunity to secure exact maintenance costs on seven different experimental sections, and has resulted in the development of a system of maintenance cost records to obtain ton-mileage figures.

The complete details of these experiments were published in Bulletin 105 of the Department of Agriculture, but a short résumé is given for the purpose of rendering more intelligible the discussion, which applies the system to this road as an example.

ROCKVILLE PIKE TREATED WITH BITUMINOUS COATS

The Rockville Pike was a macadam road originally constructed with quartzite and patched with limestone from time to time. At the time of the experiments it had become rough and badly worn, which made resurfacing necessary before the application of any surface treatments. The old surface was therefore broken up, scarified, reshaped and rolled, after which from 3 to 3½ in. of new limestone was added and the surface was finished as waterbound macadam. The road was graded 25 ft. wide in both cuts and fills, and the surface of the finished macadam had a width of 15 ft. and a crown of 0.6 in. per foot. The portion included in the first three experiments was completed in July, 1913, and the remainder in October, 1913. Surface treatment began with Experiment 1 on Sept. 5 and continued in the order of experiment numbers until Dec. 5, when No. 7 was completed.

The surface of the macadam was thoroughly swept with a horse-drawn street sweeper, and any hard cakes were removed with shovels. All applications were made at the approximate rate of 0.5 gal. per square yard, with 600-gal. horse-drawn distributors equipped with gasoline pumps, which developed about 40 lb. pressure at the nozzles. The applications were immediately covered with either dustless trap rock screenings passing a ¾-in. screen or pea gravel passing a ⅝-in. screen and free from any appreciable amount of sand passing a 10-mesh per lineal inch screen. The trap rock was used on the south half of each experiment and the gravel on the north half.

In Experiments 2, 3 and 7, products adapted to cold application were used, although owing to the lateness of the season, it was necessary to warm them slightly. The products used in Experiments 1, 4, 5 and 6 were viscous fluid products which were heated to an average temperature of about 200 deg. Fahr.

The cost per square yard of each form of treatment is shown in Table 1.

TRAFFIC CENSUS

A traffic census has been taken systematically every 13 days, and this system of census will be continued during another season according to present plans. To express the cost of maintenance in some way that would not only be comparable as among the various sections of the present experimental road, but also with other experimental roads that might later be constructed, a study was made of the various methods of correlating traffic and maintenance costs. None customarily used were considered satisfactory.

The method of stating vehicles or tons per yard or foot of width is misleading, and this is specifically the case on some sections of the experimental roads now under observation by the Office of Public Roads.

Wherever traffic in two directions is markedly different in quantity or weight, the road wears much faster on the side bearing the heavier traffic. There are specific instances of this on the experiments now under observation, where, especially on hills having the direction of heavy haul up hill, the road wears much faster on the right side than on the left. Some level sections also demonstrate a tendency for traffic to select and follow a beaten path, particularly where the road is wider than the traffic requires. This fact holds true on both bituminous macadam and cement concrete. A traffic figure per yard of width in such cases would indicate a lower traffic in the direction of heavy haul and a higher traffic in the direction of light haul. Under such conditions, the width of road could be increased and the resulting traffic index would change, but the cost of maintenance would not change proportionately, and might change very little.

EUROPEAN TRAFFIC COEFFICIENTS

The system of traffic coefficients sometimes used in Holland gives an abstract figure. The method of reducing traffic to "collars" or "yokes," as used in France and Austria, serves to give a concrete figure, but unless a further conversion to tonnage is made, it is no better than the vehicle count.

If the type and relative effect of traffic are considered in the reduction of the census count to "collars," and if the studies have been sufficient to arrive at accurate conversion factors, an expression for the tonnage can be found, and then this method of expressing traffic is excellent.

PART OF EXPERIMENTAL SECTION ON ROCKVILLE PIKE, NEAR WASHINGTON

DIFFICULTIES

But as stated hereafter, the difficulties and inaccuracies of this method are so many that its practicable use is open to much question.

In the United States, even in small areas, no such adequate studies have been made; and for that reason the method of "collars" was not considered satisfactory. Further, it now appears very doubtful if any studies can be made that will produce sufficiently accurate data for converting the various types of modern traffic to a single unit.

TABLE 1—CONSTRUCTION AND MAINTENANCE COSTS PER SQUARE YARD ON ROCKVILLE PIKE TO DEC. 31, 1914

Sections	Bituminous material	Date completed	Length (feet)	*Cost per sq. yd. (cents)	Surface maintenance per sq. yd. (cents)	Total cost of surface per sq. yd. (cents)	Surface maintenance per mile for one year	Total maintenance per mile for one year
1	Refined coal tar (hot)	Sept. 22, 1913	6105	12.34	1.58	13.92	$139.04	$332.93
2	Refined water-gas tar (cold)	Sept. 24, 1913	7380	9.55	7.56	17.11	665.28	739.11
3	Asphaltic petroleum (cold)	Sept. 30, 1913	7400	9.05	6.00	15.05	528.00	576.26
4	Residual asphaltic petroleum (hot)	Oct. 15, 1913	7100	11.28	1.61	12.89	141.68	215.18
5	Residual asphaltic petroleum (hot)	Nov. 21, 1913	6775	11.30	2.00	13.30	176.00	237.37
6	Water-gas tar preparation (hot)	Nov. 26, 1913	6325	11.71	1.88	13.59	165.44	219.47
7	Asphaltic petroleum (cold)	Dec. 5, 1913	6689	10.03	0.71	10.74	62.48	106.28

*Average for trap and gravel.

TABLE 2—COMPARISON OF WEIGHTS APPLIED TO VARIOUS CATEGORIES OF TRAFFIC

	U. S. Office of Public Roads Categories	Tons	English Road Board Categories	Tons
1.	Loaded 1-horse wagon	0.88	Heavy vehicle, 1-horse	1.25
2.	Unloaded 1-horse wagon	0.28	Light vehicle, 1-horse	0.4
3.	Loaded 2-horse wagon	1.57	Heavy vehicle, 2-horse (or more)	2.5
4.	Unloaded 2-horse wagon	0.47	Light vehicle, 2-horse	0.6
5.	Loaded 4-horse wagon	3.88	Heavy vehicle, 2-horse	2.5
6.	Unloaded 4-horse wagon (gears)	0.54	Light vehicle, 2-horse	0.6
7.	1-horse pleasure vehicle	0.28	Light vehicle, 1-horse	0.4
8.	2-horse pleasure vehicle	0.47	Light vehicle, 2-horse	0.6
9.	Rubber-tired horse vehicle	0.28	Light vehicle, 1-horse	0.4
10.	Saddle horse	0.50	Horses, led or driven	0.5
11.	Motorcycle	0.20	Motorcycles	0.13
12.	Excessively heavy vehicle	3.94	Omnibuses, 2 or more horses	3.0
13.	Motor runabout	1.68	Motor cars	1.6
14.	Motor touring car	2.00	Motor cars	1.6
15.	Loaded motor dray	2.43	Motor van, covered	2.5
16.	Unloaded motor dray	1.23	Motor van, covered	2.5
	(Draught horses)	0.50	Horses, drawing vehicles	0.5

The system of traffic coefficients as proposed by Dr. L. R. Wentholt at the Third International Road Congress, 1913, and reported in Rep. 91, page 6, of that congress, depends on elaborate comparative studies of the effects of traffic. It is to be noted, however, that the wear of different forms of traffic separately considered in experimental tests, such for instance as were made at Detroit, does not by any means represent the wear of that form of traffic when intermingled in varying proportions with several other kinds of traffic.

IMPOSSIBILITY OF USING FIXED INDEX

It has been demonstrated to the engineers of the Office of Public Roads that changes alone in the proportions of horse-drawn and motor-driven traffic affect the wear of traffic on bituminous surfaces. It becomes impossible, therefore, to assign to any type of traffic a fixed index expressing the value of that traffic in terms of a chosen unit. Such index would apply in only one set of conditions; and as these conditions are constantly changing on the same road, and are seldom to be found alike on any two roads, it becomes impracticable to adopt a sliding scale of values. Furthermore, a set of indices once properly adjusted to express the respective wear of different kinds of traffic on one type of road surface most certainly would not be accurate in the same degree as indices of respective wear on an entirely different type of construction.

Just how then to evaluate these varying factors in the matter is not at present seen from any practicable point. Traffic censuses are taken much too infrequently as it is, and anything that complicates the matter will defeat its own purpose.

MAINTENANCE COST PER TON-MILE

For these reasons it appears that the clearest idea of the traffic will be given by expressing it in tons and showing by tabulation and percentages the various kinds of traffic. The maintenance costs can then be expressed per ton-mile of traffic. The ton-mile is directly reducible for the section between census observation points, and these points can be so located as to include between them definite experimental or accounting sections, each of which is treated as a whole for maintenance purposes.

Although reduction to such a unit as a "yoke" or "collar," or expression of traffic by a "coefficient" weighted to account for the effects of various kinds of traffic, fails to furnish a representative or lucid expression for comparing traffic costs, the results secured on the ton-mile basis, on the other hand, would change with the amount and weight of traffic, furnishing a comparable figure under all conditions. If the traffic was for some local reason concentrated on a single path, it would not affect the maintenance per ton-mile, because the rest of the surfacing would be relieved of traffic in the same ratio that the traveled path was overburdened.

VEHICLE WEIGHTS

To arrive at tonnage figures to apply to the various categories of traffic, studies were made of vehicle weights and curves, reproduced herewith, plotted for several different types of vehicles. From an observation of the traffic, a point on the curve for each general type of vehicle was selected, so placed as to represent the average condition of loading for that type passing over the road. The sum of ordinate and abscissa for this point gave a figure to be expressed in tons for loaded vehicles of the type, and the abscissa gave the average weight of vehicle. The roughness of this method is recognized. It depends largely on personal knowledge concerning the general traffic and on the exercise of judgment. But so far any more accurate method has been impracticable, owing to the great variety of materials constituting the loads and the impossibility of weighing the miscellaneous passing traffic.

The weights arrived at by the method adopted have been compared in Table 2 with the weights prescribed after much study by the English Road Board.

LIGHTER WEIGHT OF AMERICAN VEHICLES

A generally lighter construction of our single rigs and farm vehicles is brought out and is probably characteristic. The categories are not entirely comparable, as, for instance, where no distinction is made by the Road Board between motor runabouts and touring cars. But the general relations of the two lists of weights are such as to provide a good common sense check on the sufficiency of the method adopted.

TABLE 3—NUMBER AND PERCENTAGE OF VEHICLES ON EXPERIMENTAL ROAD DURING YEAR ENDED DEC. 31, 1914

	Number			Percentage		
Categories	Section 1	Section 2	Sections 3 to 7	Section 1	Section 2	Sections 3 to 7
Loaded 1-horse wagon	10,193	7,848	6,262	5.1	4.7	4.5
Unloaded 1-horse wagon	9,056	7,231	6,009	4.5	4.4	4.3
Loaded 2-horse wagon	15,781	12,243	9,842	7.8	7.4	7.0
Unloaded 2-horse wagon	10,207	8,326	7,062	5.1	5.0	5.0
Loaded 4-horse wagon	842	744	674	0.4	0.5	0.5
Unloaded 4-horse wagon	562	491	435	0.3	0.3	0.3
1-horse pleasure vehicle	10,670	7,568	5,504	5.3	4.6	3.9
2-horse pleasure vehicle	1,179	927	744	0.6	0.6	0.5
Rubber-tired horse vehicle	267	267	267	0.1	0.2	0.2
Saddle horse	3,903	3,426	3,117	1.9	2.1	2.2
Motorcycle	14,714	11,372	9,154	7.3	6.9	6.5
Excessively heavy vehicle	2,457	1,994	1,685	1.2	1.2	1.2
Motor runabout	33,177	27,448	23,643	16.5	16.6	16.9
Motor touring car	72,966	62,618	55,711	36.2	37.9	39.6
Loaded motor dray	10,937	8,550	6,950	5.4	5.2	4.9
Unloaded motor dray	4,689	3,973	3,482	2.3	2.4	2.5
Totals	201,600	165,026	140,541	100.0	100.0	100.0

On a contract job under way in the vicinity of the experimental road, it was necessary to take the tare and loaded weights of about seventy-five contractor's dump wagons, and these weights compared with those furnished by the curve are in all cases a little high for that type of outfit, as might be expected; and this indicates that the values obtained from the curves are fair and probably conservative.

These values to the nearest tenth have been used in arriving at tonnage figures, and each draught animal has been given due weight. The so-called French system of taking observations has been followed, using a list of categories suited to the customary traffic on the road.

FIGURING THE TON-MILES

The tonnage figures so obtained are valuable, because among the seven sections of the experimental road, they are comparable in all respects. Further, if the tonnage coefficients, as determined, are accepted, these figures for ton-miles are, in general, comparable in all cases to which the tonnage coefficients might be applied. The variants are, of course, the proportions of different types of traffic.

TABLE 4—TONS AND TON-MILES ON EACH SECTION OF EXPERIMENTAL ROAD DURING YEAR ENDED DEC. 31, 1914

Section	Length (Miles)	Tons	Ton-Miles
1	1.156	343,418	396,991
2	1.398	283,158	395,855
3	1.402	243,117	340,850
4	1.345	243,117	326,992
5	1.283	243,117	311,919
6	1.198	243,117	291,254
7	1.267	243,117	308,029

The results are first tabulated, Table 3, to show the number of vehicles recorded. These figures are computed from the observed traffic on twenty-six observation days extending from Jan. 1 to Dec. 31, 1914.

By applying the tonnage coefficients of Table 2, the number of tons of traffic passing over the road are found. The totals are given in Table 4. Taking the lengths of experimental sections as described above, the ton-miles of traffic on each section are also found and are shown in Table 4.

MAINTENANCE CHARGES

The maintenance charges have been secured by an accurate system of daily time reports sent in by patrolmen, supplemented by inspections and personal attention to details of field accounting. The daily personal reports of patrolmen must account for 8 hours' work. A form card was used on which the patrolmen distributed their time by hours on each section, and by different kinds of work done. They also reported materials used.

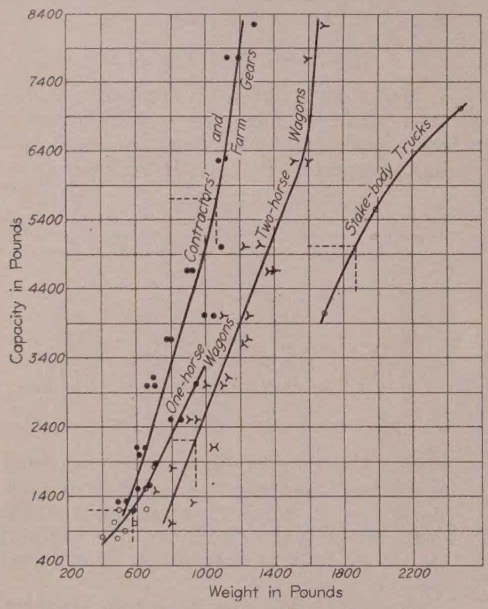
In the office, a set of accounts was opened to segregate the various items reported by the patrolmen and to provide for general and distributive charges. A property account was opened and debited with materials purchased, so that all charges against them showed up to the point where the patrolmen picked up small quantities for repairs. The quantities reported used were credited in the prop-

TABLE 5—MAINTENANCE COSTS PER TON-MILE OF TRAFFIC FOR YEAR ENDED DEC. 31, 1914

Section	Maintenance charges A Surface	Slopes	Ditches	Misc.	Total	B Ton-miles of traffic	A/B Cost of surface maint. per ton-mile in cents	B/A Ton-miles of traffic per one cent of maintenance
1	$160.59	$11.63	$48.51	$164.14	$384.87	396,991	0.0405	24.7
2	929.30	18.92	40.43	44.62	1,033.27	395,855	0.2348	4.3
3	740.14	17.90	19.55	30.32	807.91	340,850	0.2171	4.6
4	200.51	40.90	6.50	41.40	289.31	326,992	0.0613	16.3
5	226.24	30.51	5.74	42.05	304.54	311,919	0.0725	13.8
6	198.00	18.05	4.50	42.37	262.92	291,254	0.0680	14.7
7	79.57	18.57	4.50	32.70	135.34	308,029	0.0258	38.7

erty account at a calculated unit price that varied from time to time, as purchases were made on different quotations or on different conditions of delivery. In every instance balances of material were carefully weighted in securing an average price to apply to the entire lot as new supplies were purchased.

These property accounts gave a close check on the waste of materials when piled along the road in small scattered quantities. The waste as developed was 0.5 per cent for trap screenings; 3.5 per cent for gravel, and 0.2 per cent for bitumen. These quantities are so small as to be negligible and indicate that in general under the patrol system small quantities of material may be stored in scattered piles without undue waste.



CAPACITY AND WEIGHT OF WAGONS

From the segregated maintenance charges accounts we get the amounts shown in Table 5, and by applying the ton-miles of traffic from Table 4, we obtain the figures showing surface maintenance per ton-mile and ton-miles of traffic per one cent of maintenance.

FINAL FIGURES

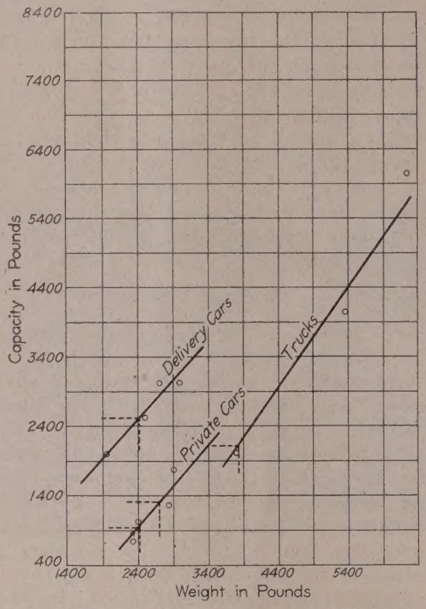
To interpret these results for other cases, some further knowledge should be had regarding the proportions of different forms of traffic on which these maintenance costs are based.

TABLE 6—TYPES OF TRAFFIC ON EXPERIMENTAL ROAD DURING YEAR ENDED DEC. 31, 1914

	Number	Percentage of number	Tons	Percentage of tons
Section 1				
Horse-drawn vehicles....	65,117	32.3	106,254	30.9
Motor-driven vehicles....	136,483	67.7	237,164	69.1
Section 2				
Horse-drawn vehicles....	51,065	30.9	83,762	29.6
Motor-driven vehicles....	113,961	69.1	199,396	70.4
Sections 3 to 7				
Horse-drawn vehicles....	41,601	29.6	68,881	28.3
Motor-driven vehicles....	98,940	70.4	174,236	71.7

Table 6 shows the numerical proportions of horse-drawn and motor-driven vehicles. Table 3 shows the proportions of tonnage with respect to the several categories of traffic observed. In this case the draught-horse tonnage is properly distributed.

Finally, the surfacing charges are split to show the amounts spent for labor and materials (Table 7), and the various amounts of materials used per square yard for the full year are shown in detail for each section (Table 8).



CAPACITY AND WEIGHT OF MOTOR CARS

The figures given above are in every case the actual amounts directly spent on the items of maintenance indicated. There were, of course, in the conduct of the work certain general and distributive charges, indicating lost days, days on which general patrol work was done, and other charges not directly assignable to any one section. On sections 1, 2 and 3 these general charges amounted to $66.02 for each section, and on sections 4 to 7, inclusive, to $52.25 for each section. The total cost of maintenance as shown in Table 5 should properly be increased by these amounts. Further, the figures given contain no element of engineering or general supervision and no overhead of any kind, such as unexpendable equipment charges, etc.

CHARACTER OF MAINTENANCE

An effort has been made to maintain the sections at all times in perfect condition, and to permit no defects in the surface to increase beyond the limit which could be regularly cared for by a patrolman who gives his attention to approximately 6 miles of road. When this limit is reached a renewal treatment of the section involved is resorted to. Thus Experiment 2, which was completed Sept. 24, 1913, was retreated July 1, 1914, with an application of the same kind of material originally used, and Experiment 3, which was completed Sept. 30, 1913, was similarly retreated on Oct. 25, 1914. In each case these sections had reached a condition where it was impracticable to maintain them satisfactorily by simple patrol repairs.

The maintenance costs here presented include not only the routine, patrol maintenance charges, but also the charges incident to retreatment. In the retreatment of Section 2, the area, comprising 12,300 sq. yd., was given an average of 0.29 gal. per square yard of bitumen and dressed with trap chips or gravel at the rate of 85.7 sq. yd. of surface to each cubic yard of top dressing. The bitumen cost 9.5 cents per gallon distributed, the trap, $3.77 per cubic yard piled along the section, and the gravel, $2.167 per cubic yard similarly placed. Spreading the top dressing cost $65.40. The unit costs for the treatment were as follows:

Bitumen	$0.028 per sq. yd.
Trap chips	0.044 per sq. yd.
Gravel	0.025 per sq. yd.
Labor	0.005 per sq. yd.
Total trap covered...............	$0.077 per sq. yd.
Total gravel covered	0.058 per sq. yd.

Section 3 was retreated Oct. 25, 1914, when the section was just one year and twenty-five days old. This section had suffered severely by reason of culvert repairs made necessary by the failure of an old 24-in. pipe culvert that had not been replaced at the time of construction in 1913, and by the burning out of a section during the first winter by bon-fires of leaves thoughtlessly built by pedestrians along the edge of the surfacing. In addition, the frost had heaved several spots, breaking the macadam and making systematic macadam repairs necessary.

Of these repairs 64.49 sq. yd. were properly chargeable against the maintenance of the section. The total cost was $67.78, or $1.051 per square yard. Owing to the fact that it was undesirable to interfere with customary traffic, these repairs were penetration patches in all but two cases. Waterbound patches could not be held under the traffic conditions existing. Considerable small patching of the bituminous surface also was necessary before retreatment.

TABLE 7—DISTRIBUTION OF SURFACE MAINTENANCE CHARGES ON ROCKVILLE PIKE

Sections	Labor	Trap Cu. ft.	Trap Cost	Gravel Cu. ft.	Gravel Cost	Bitumen Gallons	Bitumen Cost	Total
1	$70.69	409	$58.71	60	$4.38	196.5	$26.81	$160.59
2	99.00	2390	335.28	1738	138.38	3735.5	356.64	929.30
3	220.83	1751	163.90	1781	153.66*	2552.0	201.75	740.14
4	45.75	703	118.62	390	28.47	66.0	7.67	200.51
5	77.25	582	95.08	578	42.31	108.5	11.60	226.24
6	60.59	584	100.18	446	32.60	29.0	4.63	198.00
7	33.31	91	13.07	108	8.29	237.0	24.90	79.57

*Includes sand used at time of retreatment.

USE OF SAND IN RETREATMENT

It was decided to use torpedo sand over

TABLE 8—MATERIALS USED PER SQUARE YARD OF ROAD MAINTAINED ON ROCKVILLE PIKE

Section	Trap chips (cu. ft.)	Gravel (cu. ft.)	Bitumen (gallons)
1	.065	.016	.019
2	.331	.342	.303
3	.293	.281	.207
4	.117	.067	.006
5	.094	.113	.010
6	.117	.080	.003
7	.016	.019	.021

all this section at retreatment, and costs for the work are here presented:

Sand at the rate of 1 cu. yd. on 107 sq. yd.	$0.0199
Oil at the average rate of 0.176 gal. per sq. yd.	0.0123
Labor, including sweeping, spreading and brooming oil, and spreading sand	0.0059
Team-hauling	0.0005
Total cost per square yard	$0.0386

The total cost of retreatment was $476.88.

Experiment 7, the remaining one of the three cold surface treatments, will very likely require a renewal treatment in the spring of 1915.

PARTIAL CAUSES OF FAILURE

An interesting comparison of the partial causes of failure in these three experiments arises from the fact that in Nos. 2 and 3 the most rapid deterioration was on the portion covered with pea gravel, while in No. 7 the reverse is apparently the case to some extent. This was very evidently due to the coarser quality of the gravel used on Nos. 2 and 3, which was at times of such size that a thin fluid material would not retain it permanently even after rolling.

The maintenance of Experiments 4, 5 and 6, on which hot applications were made, has been confined largely to the spreading of additional screenings or gravel. It is to be noted that all of these experiments were completed in the late fall, and a small amount of covering material sufficed to carry them over the winter. The "bleeding" incident to warm spring weather, however, necessitated constant attention to prevent the surface from being torn off by traffic.

The maintenance of Experiment 1 and on parts of No. 2 has been largely necessitated by an apparent hardening of the surface mat, which has been gradually cut back by traffic from the edges toward the middle of the road. In this way, the clean underlying macadam has been exposed in a strip for a width of a foot or more along the sides, necessitating considerable patching, while the remainder of the bituminous surface remains smooth and practically intact.

The amounts of gravel and trap used in making repairs, taken from the property account and tabulated in Table 7, indicate the relative expenditure for routine maintenance on the gravel and trap divisions of each section.

THE BUCKHANNON & NORTHERN RAILROAD in West Virginia has been completed and is to be opened for regular traffic this month.

Treat Illinois Sewage with Activated Sludge

Marked Reductions in Time Required for Nitrification Are Shown by Experiments of State Water Survey

EXPERIMENTS on the treatment of sewage by the activated sludge principle at the laboratory of the Illinois State Water Survey in Urbana have indicated a marked reduction in the time required for complete nitrification as compared with the time required when simple aeration was employed. With straight aeration this time varied from 15 to 33 days while in the second treatment, when the sludge was added, complete nitrification was effected in only 4 days and the reduction in the amount of air used was from 4830 to 1270 cu. ft. The results were discussed in detail by Dr. Edward Bartow and F. W. Mohlman in a paper presented recently before the American Chemical Society at New Orleans, the source of the following notes:

The first experiments were made using bottles of 3 gal. capacity. Later there was constructed a tank 9 in. square and 5 ft. deep, with a plate-glass front and back to permit easy observation of the condition of the sewage and sludge. A porous plate was placed 4 in. above the bottom. An inlet for air and an outlet for any water which might pass through the plate were provided in the space below the plate. Compressed air, furnished by the University of Illinois power plant, is measured through an ordinary gas meter. The purified sewage is removed by means of a siphon.

Sewage from the city of Champaign is used. It is collected from a point in the main sewer at the edge of the city, at least 2 mi. from the outfall. When taken it is fresh. Average analyses indicate that it is a fairly strong domestic sewage. It contains no trade wastes.

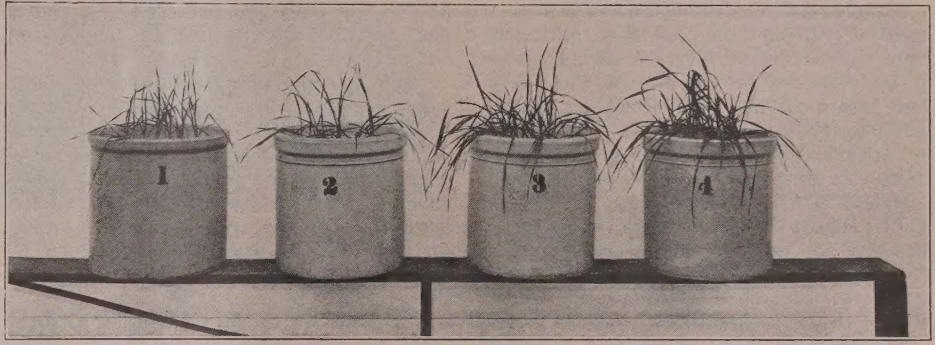
AERATION WITHOUT SLUDGE

Air was blown into five separate portions of sewage until complete nitrification was accomplished. To show the progress of the reaction tests for free ammonia nitrites and nitrates were made at intervals during each treatment. The time required for complete nitrification has varied from 15 to 33 days. The best result was obtained in the tank, where the air was distributed through the porous plate. For all analyses samples of the supernatant liquid were taken after 1 hr. settling without filtration. In each case the free ammonia nitrogen was almost quantitatively changed to nitrite nitrogen, then the nitrite nitrogen in turn was changed almost quantitatively to nitrate nitrogen. This change is illustrated in diagrams 1 and 2. The formation of nitrate in the tank was accomplished in 15 days with the use of 4830 cu. ft. of air.

AERATION WITH SLUDGE

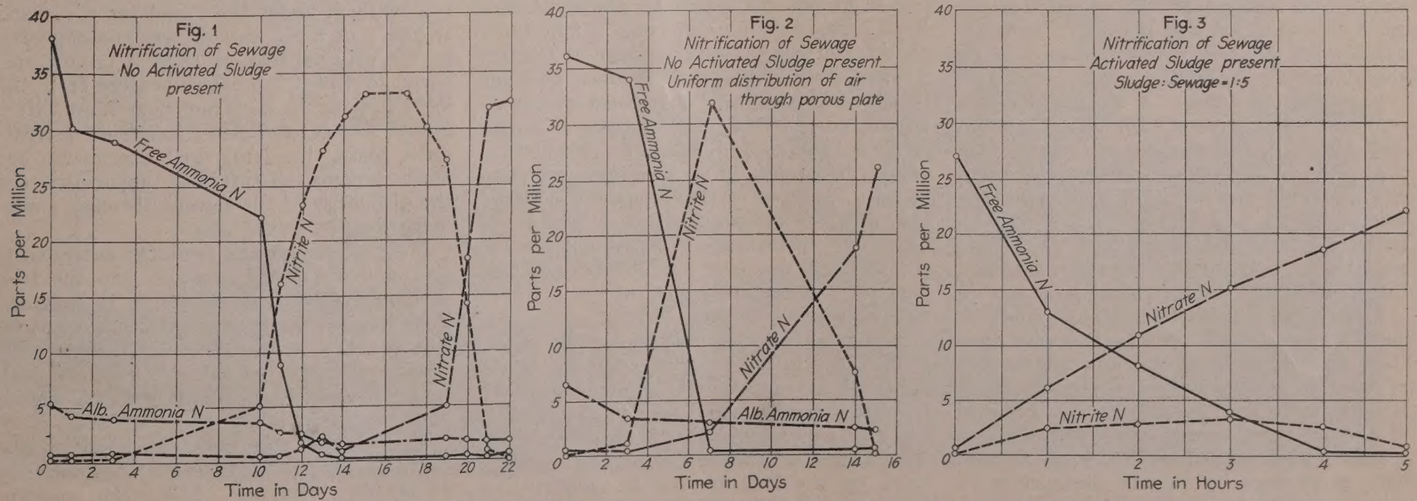
The supernatant liquid was siphoned off and a fresh portion of sewage added to the sludge. In this, the second treatment, the effect of a small amount of sludge is well illustrated by the reduction of the time required for complete nitrification from 15 to 4 days and the reduction in the amount of air used from 4830 to 1270 cu. ft. Thirty-four parts per million of free ammonia nitrogen in the raw sewage produced 23.8 parts per million of nitrate nitrogen in the supernatant liquid.

The supernatant liquid was again si-



POT CULTURES TO DETERMINE FERTILIZER VALUE OF DRIED SLUDGE

No. 1, no nitrogen; No. 2, nitrogen from dried blood; Nos. 3 and 4, dried sludge



FIGS. 1-3—NITRIFICATION OF SEWAGE WITH AND WITHOUT THE ADDITION OF ACTIVATED SLUDGE

phoned off, fresh sewage added and aeration continued. In this, the third treatment, nitrification was complete in 2 days and but 720 cu. ft. of air was used. Thirty-three parts per million free ammonia nitrogen produced 22.3 of nitrate nitrogen. In the twelfth treatment the purification was completed in less than 8 hr. with the use of less than 128 cu. ft. of air; 36 parts per million as free ammonia nitrogen produced 29.5 parts per million of nitrate nitrogen. In the thirty-first treatment with sludge and sewage in the proportion of 1:5 purification was complete in less than 5 hr.; 35 cu. ft. of air were used, equal to 0.20 cu. ft. per square foot of surface area per minute, or about 3 cu. ft. per gallon of sewage. No attempt was made to determine the minimum amount of air required.

Samples taken at the end of each hour of aeration during some of the treatments were tested for stability. A sample taken at the end of 1 hr. aeration in the thirty-first treatment had not decolorized methylene blue at the end of 12 days. Since in 1 hr. nitrification was not complete it is, therefore, evidently unnecessary to obtain complete nitrification in order to obtain a stable effluent. Since it is impossible to separate the oxidized liquid entirely from the sludge it is probable that the stability is promoted by the oxidizing action of the nitrate in the residual liquid.

The progress of nitrification in the presence of activated sludge is apparent. The results are shown in diagram 3. From this and from other series of analyses it is indicated that there is no quantitative conversion of free ammonia to nitrite, followed by oxidation to nitrate, but that nitrates are formed simultaneously with nitrites.

The number of bacteria was determined during one treatment. Samples were taken after one hour settling. The raw sewage showed a bacteriological content of 750,000 per cubic centimeter. The supernatant liquid after aeration and settling one hour showed but 20,000. Further tests are planned.

Worms in Sludge

Through the courtesy of Professor Frank Smith, of the University of Illinois, biological examinations have been made of the sludge. Among the microscopic animals found are many Vorticella and Rotifera, but the predominant organism is an annelid worm known as Aeolosoma hemprichi. This organism is about 2 to 5 mm. long and quite slender. It abounds in various kinds of fresh-water bodies where there is an abundance of decaying organic material and thrives especially well where there is much fermentation and in waters contaminated with sewage, provided there is an abundance of oxygen.

It belongs to a group of worms in which reproduction occurs very rapidly by asexual methods. A fission zone is formed near the middle of the body of the parent worm and develops the head of one daughter worm and the tail of the other, and thus two new worms are formed from one. This requires not over 2 or 3 days and is repeated for an indefinite number of generations.

They feed greedily and almost continuously on any small organic particles that they can obtain and presumably destroy at least their own weight of organic matter every day and probably more. Because of the mode of reproduction it takes but a short time to produce extensive colonies with great capacity for the destruction of organic material.

The activated sludge has evidently been developed by the multiplication of these worms originally present in the sewage, and the species found at varying points might differ. The sludge does not have an unpleasant odor, due to the fact that it consists largely of living organisms. If kept for a long time in a moist condition without air it will putrefy.

Chemical Composition of the Sludge, and Its Value

Analyses of the sludge made by W. D. Hatfield have shown the following results: After drying first on the water bath and then for 3 hr. in an oven at 100 deg. C. the loss or moisture was 95.54 per cent. The dried material contained 6.3 per cent nitrogen, 4.0 per cent fat, 1.44 per cent phosphorus, equal to 3.31 per cent P_2O_5 and 75 per cent of volatile matter by loss on ignition.

From this chemical data the dried sludge would evidently have value as a fertilizer. If we calculate the value as 20 cents per pound of nitrogen and 12 cents per pound of phosphorus it would have a market value of $29 per ton. In order to determine whether the theoretical value would correspond to the actual value four pot cultures were started. Portions of dried sludge were added to two pots (Nos. 3 and 4), an equivalent amount of nitrogen from dried blood to another (No. 2) and no nitrogen to the fourth (No. 1). At the end of 18 days the cultures containing the dried sludge show better growths than the culture containing an equivalent amount of nitrogen from dried blood and far better growth than the culture to which no additional nitrogen was added.

Yard Expansion Relieves Congested Detroit Facilities

THE recently completed expansion of the West Detroit yards of the Michigan Central Railroad involved increasing the capacity of the yards by 2500 cars, building a modern 40,000-ton icehouse, a 600-ton, four-engine coaling station capable of unloading 100 tons per hour and a new engine house able to handle 150 locomotives a day.

The yard when completed will embrace 73 mi. of track and 374 switches. To date 68.5 mi. of new track have been laid, 23.6 mi. of track have been taken up and 310 switches have been laid. Manganese frogs are used entirely. Tracks in the classification yards are spaced on 13 and 15-ft. centers. The construction involved the separation of grades at Central Avenue and Lonyo Road, the erection of one single-track bridge and one six-track bridge at Central Avenue, two single-track bridges and one three-track bridge at Lonyo Road, one 16-ft. reinforced-concrete arch between Central Avenue and Lonyo Road, and 1,600,000 cu. yd. of fill hauled on an average more than 32 mi. The apex of the humps lies between the two streets above mentioned. The grade away from the humps is 3 per cent for 200 ft., then 1.5 per cent for 500 ft. and 0.23 per cent for the remainder of the distance to level grade.

The work was handled under the direction of G. H. Webb, chief engineer; J. F. Deimling, assistant chief engineer, and C. C. Hill, engineer of construction. The grading was handled under contract by J. R. Patton, of Chicago, and the concrete work by the Engineering & Construction Company, of Cleveland.

Three Districts for Disposal of Cleveland's Sewage

R. Winthrop Pratt Reports Departure from Original Scheme, and Outlines Plan Now Proposed for Each District

GENERAL plans for collecting the sewage of the entire city of Cleveland from three separate districts and for treatment works for each district have been completed according to a report of R. Winthrop Pratt, engineer in charge. Contracts for 11,220 ft. of intercepting sewers have been let and 3000 ft. completed. Contract has also been let for the excavation on the southerly treatment plant. A breakwater 2600 ft. long is necessary at East 140th Street to enable the city to reclaim 30 acres of land on which to build works; 700 ft. are completed. The testing-station operations closed down in September, 1914, and results are now ready for the printer.

Departure from Original Plans

The sewage treatment tests, together with an engineering study of the plan for the sewer system proposed in 1896, led to the conclusion that it would be much better to depart from this plan and establish three main outlets for the city instead of one. The city was therefore divided into three sanitary districts and for convenience they were called the southerly, westerly and easterly districts.

The revised system of main sewers have a capacity for accommodating an ultimate population of 1,700,000 people as against 1,000,000 for the system as originally planned; both these capacities being figured on the basis of 400 gal. per capita. Both the revised and the original systems will cost about the same, $3,859,000.

In regard to the relative cost of sewage treatment under the original and revised plans, there will be little difference. Under the revised plan, oxidizing devices of filters will be required for the southerly plant, thus increasing the cost; but on the other hand, under the revised plan, the sewage will arrive at all three plants in a much fresher condition and may therefore be treated with maximum economy and with a minimum danger from odors.

Southerly District

For the southerly district—that part of the city south of Kingsbury Run and east of Cuyahoga River—the treatment plant will consist of grit chambers, sedimentation tanks and sprinkling filters. Instead of collecting the sewage from the west side and conveying it under the Cuyahoga River and thence 7 or 8 mi. east as was contemplated by the original plan of 1896, it is now proposed to collect the entire sewage from the West Side at the lakefront near West Fifty-eighth Street, and there construct a treatment plant, involving grit chambers, five mesh screens, disinfection apparatus and the discharge of the sewage through a submerged outlet in the lake.

Most of the sewage from the entire easterly district already passes into the lake at East 140th Street, and it is intended to install on the land now owned by the city at this point a sewage treatment plant consisting of grit chambers, sedimentation tanks of relatively small capacity and a disinfection apparatus.

The cost of the work completed, under contract or provided for by ordinance is $1,353,000. During 1915 work contemplated but for which bonds have not been sold is as follows: Southerly interceptor, $577,000; Walworth Run division sewer, $400,000; southerly and westerly division treatment works, $600,000 and $100,000 respectively.

Aeroscope a Novel Feature of Panama-Pacific Exposition

Mammoth Steel Structure, Designed and Operated Like a Bascule Bridge, Built for Amusement Purposes

CONSISTING of a 243-ft. lifting arm counterbalanced on a 41-ft. 6-in. tower, and supporting at its end a double-deck passenger car with a capacity of 100 to 120 persons, the aeroscope will be one of the most novel contrivances for furnishing diversion to the visitors at the Panama-Pacific International Exposition. Revolving horizontally with the tower, and operated vertically like a single-leaf bascule bridge, this arm propels the car, in various gyrating bird-like motions, to a height of 265 ft., from which height is obtained a seaward view of 200 mi. The tower, arm and car, made of structural steel, together with the operating machinery, weigh approximately 320 tons.

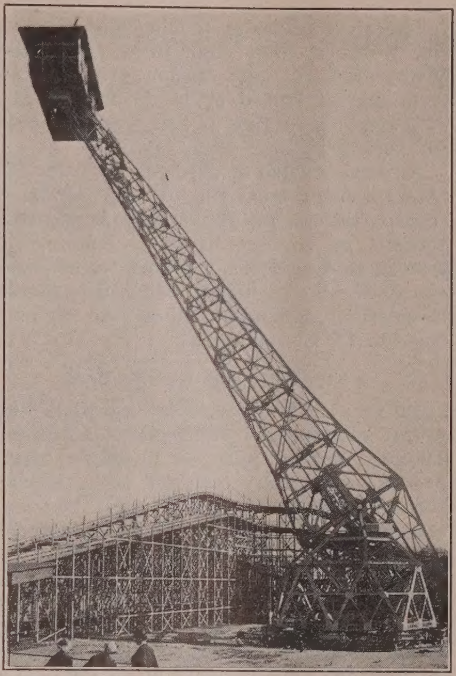
The tower is supported on eight steel 4-wheeled trucks, four of which are driven by their own 15-hp motors, and revolves about a perpendicular axis on a circular track of 30-ft. 3-in. radius. A standard-gage track is used, composed of 90-lb. rails, tied together with radial rods, and laid on wooden ties, closely spaced, imbedded in a gravel-ballast foundation. The load on each wheel is approximately 20 tons.

Supporting the lifting arm, the steel tower, pyramidal in form, is provided with forged steel trunnion bearings on which the arm turns vertically. The vertical movements are controlled by two 11-hp motors acting through a set of cast-steel gears.

Balancing the Arm and Car

Built into the structural-steel frame, the counterweight is composed of a monolithic block of reinforced concrete, 150 cu. yd. in volume, with recesses for additional material for adjustment. The arm is designed to carry its own weight, the weight of the car, and a live load of 15,000 lb. within the car.

To insure a constant live load on the arm of the structure, and to preserve an exact equilibrium, a mechanical device is arranged underneath the car, automatically allowing the intake or discharge of sufficient water to compensate for the reduction or increase in number of passengers. This also serves to maintain the car at the platform level, whether loaded or empty.



THE CAR WILL CARRY 120 PASSENGERS

While raising or lowering the arm, it is necessary to keep the car in a vertical position. This is accomplished by the use of a parallel link mechanism, running along the sides of the arm from the tower to the car, composed of 3-in. standard pipe provided with journal bearings at the four extremities.

Operation

The car is two stories high and measures 19 x 37 ft. in plan. The sides of the car are of plate glass, and the seats are arranged in such a way as to furnish each occupant an unobstructed view. Attached to the arm, a short way from the car, are two 3-hp motors actuating a pair of air propellers, one on either side, which are provided as a novelty and to assist the 11-hp motors above referreed to in raising or lowering the car. Platforms are built on the ground leading up to the car to accommodate both the outgoing and incoming passengers.

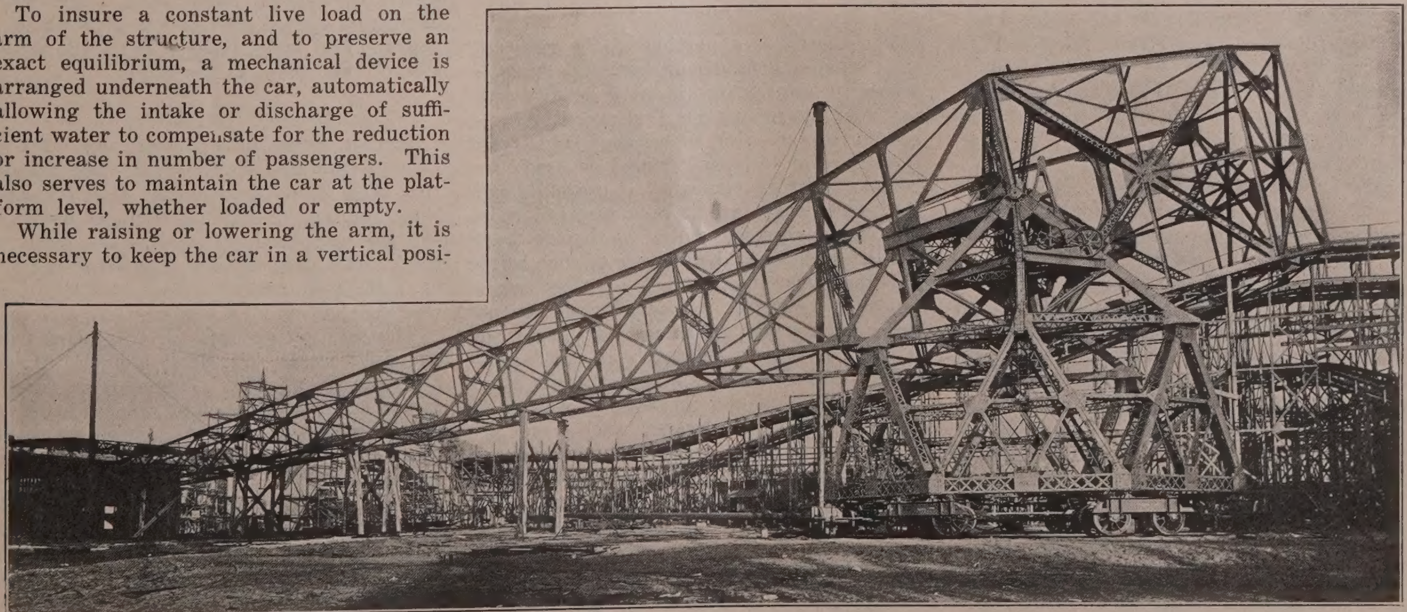
The guard on the lower deck operates two levers, one locking the arm, the other controlling the centrifugal pump connected to the ballast tank, and a hand wheel for opening and closing the gates. By means of a telephone connection he directs the operator in the tower regarding the motion of the car. The guard on the upper deck operates the searchlight. The aeroscope is illuminated at night by means of electric lights strung along the outlines of the structure. The electrical apparatus is so arranged that it is impossible to obtain power for any of the operating equipment when the gates of the car are open.

Five Trips per Hour

The turning and lifting machinery is gaged so that the car can circle the tower three times, meanwhile rising to its extreme height and dropping again to platform level, in 9 minutes. Allowing 3 minutes for loading and unloading of passengers, it is possible to make five trips per hour. Before the arm can be swung horizontally, it has to be raised through an arc of 15 deg., at which height the car will clear all adjoining structures.

The aeroscope is one of the few all steel and concrete structures on the Zone. In height of elevation it eclipses the Ferris wheel of the World's Columbian Exposition, and it embodies some new and radical departures from past precedents, such as the large trucks by means of which horizontal rotation is effected, and the balancing device at the end of the car which compensates for the varying live load that the structure carries.

The device is called the Strauss Aeroscope, after the inventor and designer, J. B. Strauss, president of the Strauss Bascule Bridge Company, Chicago. Various features of it have been patented by Mr. Strauss. The steel was fabricated by the Modern Steel Structural Company, of Waukesha, Wis., and erected by George H. Giffin, of Seattle. The electrical equipment was furnished and installed by the Butte Engineering & Electric Company, of San Francisco. A. J. Bain, of San Francisco, was resident engineer under Mr. Strauss' direction. The aeroscope is operated by the Pacific Aeroscope Company, of San Francisco, of which E. W. A. Waterhouse is president. E. E. Barton is in charge of operation.



THE AEROSCOPE HAS THE VERTICAL MOTION OF THE BASCULE BRIDGE PLUS THE TURNTABLE MOTION OF THE SUPPORTING TOWER

When Is Land Used for Common Carrier Purposes?

Land Committee of Presidents' Conference Committee Offers Suggestions to Aid in Complying with Federal Valuation Act

WHAT constitutes "property held for purposes other than those of a common carrier" is brought into question by Order 7, relative to land matters, recently issued by the Division of Valuation, Interstate Commerce Commission. In a letter of instructions to the supervisor of land appraisals the director quotes the commission's definition of the investment in land used for transportation purposes, which reads as follows: "This account shall include the cost of land of necessary width acquired for roadway; the cost of land for station, office, shop or other grounds; for ingress to or egress from such grounds; for borrow pits, waste banks, snow fences, sand fences and other railway appurtenances; and for storage of material adjoining the right of way; the cost of land for wharves and docks, and the cost of riparian or water rights therefor. . . ." The director concedes that the Valuation Act may cover more than this definition, but instructs that when a carrier has listed lands as used for common carrier purposes which are not within the foregoing definition the land appraiser is to notify the carrier that they will not be appraised as common carrier lands until a sufficient reason has been shown why they should be.

To aid the carriers in complying with this order the carriers' land committee, through Thomas W. Hulme, general secretary of the Presidents' Conference Committee, has issued suggestions which, condensed, follow.

It will be observed that while the director prescribes Road and Equipment Account 2, "Lands used for transportation purposes," as the basis to be followed, he recognizes that the Valuation Act has a broader scope than the Interstate Commerce Commission account, but puts upon the carrier the burden of proving their claim to the inclusion as owned or used for common carrier purposes under the act such of their lands as would be excluded under the Interstate Commerce Commission account.

LANDS IN USE

As to lands in actual use for common carrier purposes it is unlikely there will be much, if any, difference of opinion as to classification between the Government representatives and the carriers; the facts will be apparent and must govern. The question, however, may be raised in some instances, whether the entire width of the right of way and the entire area of station grounds and terminals are in use because at the moment of valuation not occupied by the roadbed, tracks, structures or other facilities of the carrier, overlooking that the term "use" when applied to the operation and maintenance of a railroad implies adequate space for fire, snow and in some cases sand protection, for the work of maintenance, renewal and replacement, for drainage, for handling wrecks, for storage of material, for approaches, for safety of persons and property and many other purposes, as well as for future expansion. The disadvantages of inadequate space and its reflection in an increase in operating expenses and danger to the public are well known to the carriers and doubtless to the commission.

Therefore, carriers should claim the entire width of their right of way, and the entire area of their station grounds and terminals as owned or used for purposes of a common carrier, if being used or held for such purposes.

All lands owned or used for facilities for transshipment from rail to other forms of transportation, or for storage incidental thereto, or for storage and handling in transit, such as docks, wharves, warehouses, elevators, etc., or held for such use, should be classified as land owned or used for purposes of a common carrier.

LAND HELD FOR FUTURE USE

Differences may arise in regard to the proper classification of lands acquired for common carrier purposes, held for such purposes, but not yet needed or in use for such purposes, or, in other words, the property which every carrier to a greater or less extent acquires in anticipation of its future needs. It will no doubt be recognized by the commission that in order to protect themselves against exorbitant prices and against delay in expanding their facilities to meet the requirements of commerce—a requirement frequently so urgent that delay is serious in its consequence to the public as well as to the carriers—the carriers exercising sound business judgment have acquired property in excess of immediate requirements and are holding the same until needed, and that such property, if still being held in accordance with the intent of the carrier at the time of acquisition, should be included in the valuation as common carrier property.

There are instances where properties were acquired for common carrier purposes, but where conditions or the plans of the carriers have so changed that the intent so to use has been permanently abandoned; such properties should be classed as property held for purposes other than that of a common carrier.

Some carriers have expressed their intention of using as a test for classifying their lands not in use into carrier and non-carrier lands, whether or not the carrier would be willing to sell for a fair price? If so, the land should be classified as non-carrier land. If it would not, it should be classified as carrier land.

LEASES

The fact that a portion of the right of way, station grounds or terminal lands is leased to non-carriers is, as a general rule to which there are but few exceptions, no reason for excluding such leased lands from the schedule of lands "owned or used" for common carrier purposes. It is well known that such leases are usually made to those whose business is such as to require track facilities; that, in the absence of such leases and the structures placed by lessees on the lands covered, the carriers would be obliged to provide additional facilities; the use of the lands so leased is an aid to commerce and to the transportation facilities and business of the carriers, as well as to the business of the lessees; such leases are terminable at the will of the carrier on short notice, and it is the purpose and intention of the carrier actually to occupy and use the same whenever it may be needed in the future.

Lands are dedicated to public use within the meaning of this act when originally acquired for the purposes of a common carrier by the present or any predecessor common carrier, but where the lands were acquired for other than the purpose of a common carrier the time of dedication to public use shall be taken to be the time when the intention was formed to hold the lands for common carrier purposes.

Quincy Coagulating Basins Operate Best in Series

Replacement of Oldest Mechanical Water Filter in Country with Rapid Filters Has Now Been Accomplished

IN the new filtration plant at Quincy, Ill., series operation of the coagulation, mixing and sedimentation basins has been found to give the best results although connections are such that the two units can be operated separately or in parallel. Special interest is attached to the new filters, as it replaces one of the oldest mechanical plants in this country built 14 years ago. W. L. Gelston, superintendent, presented a brief description of the 6,000,000-gal. plant at the recent meeting of the Illinois Section of the American Waterworks Association.

OPERATION

From preliminary experiments he gave the method of operation as follows: The low service pumps discharge into an open forebay where the water is treated with the first dose of sulphate of alumina. It then travels about 400 ft. over and under the concrete baffles in the mixing chambers and finally passes through sluice gates into sedimentation basin 2. This basin is 27 x 94 ft. in plan by 20 ft. in depth and is provided with a vertical concrete baffle which extends nearly the entire length of the basin on the center line. When the plant is operating at a normal rate this basin provides a travel of about 175 ft. and a period of 1½ hours for sedimentation. From the outlet side of this basin the water is drawn from the surface, over a weir, through a large sluice gate, and passes through a concrete flume to the second forebay where it receives its second dose of alum, as it begins its tortuous passage through the mixing chambers connected with basin 1. This basin is 55 x 94 ft. in plan by 20 ft. in depth and has one vertical concrete baffle on the center line around which the water must pass. The sedimentation period in this basin is about 3 hours. The water passes from the outlet side of this basin to the filters.

FILTER AREA

The six filters have a sand area 12 x 32 ft. and they are 10 ft. deep. The regulation New York Continental Jewell Filtration Company strainer system, as designed for the combined air and water wash, is used. The strainers are covered to a depth of 1 ft. with graded gravel and 30 in. of Ottawa sand of 0.38 mm effective size.

The original designs for this plant were prepared by D. W. Mead and C. V. Seastone, Madison, Wis. The contract for the construction of the plant was awarded to the New York Continental Jewell Filtration Company and this company sub-let the building construction to the Coddington Engineering Company of Milwaukee, Wis. Carl Francis was resident engineer for the filter company during the construction period, and Gilbert Pratt was in charge of its operation during the official efficiency test which was conducted by W. F. Langelier of the State Water Survey.

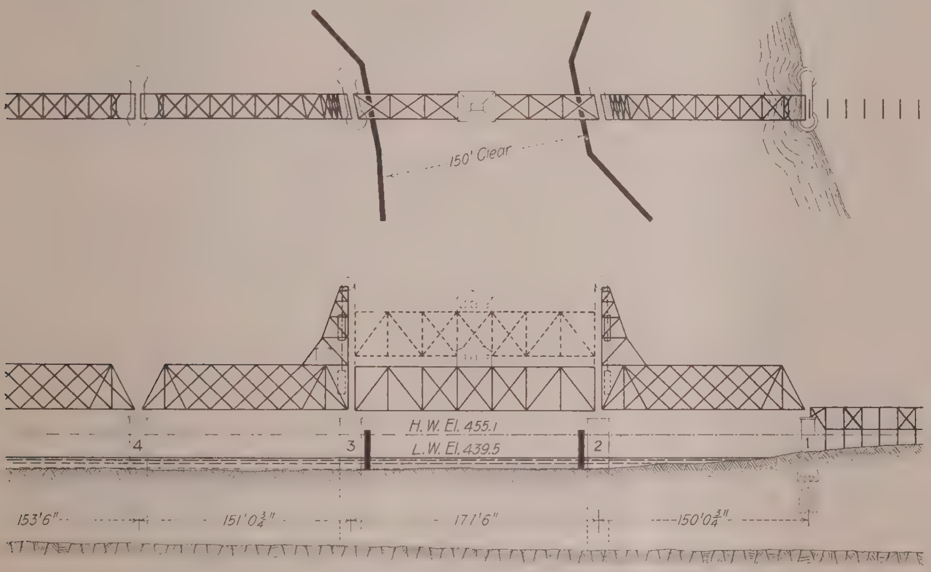
Substructure Conditions Fix Design of Chicago & North Western Bridge at Pekin

Why Twin-Cylinder Pneumatic-Caisson Piers Were Adopted —Floating Booms of Heavy Timber Protect Channel Piers

By C. F. DALSTON
Chief Draftsman, Bridge Department, Chicago & North Western Railway

TWIN-CYLINDER pneumatic-caisson piers, built in a rather unusual manner and connected by riveted trusses inclosed in solid concrete diaphragms, are a feature of the bridge of the Chicago & North Western Railway over the Illinois River near Pekin, Ill. The piers are protected from impact of boats or drift by fixed spring-bearing frames and by floating booms with adjustable anchorages.

The bridge is on the line recently put into service from Peoria to the coal fields of southwestern Illinois. It crosses the Illinois River just south of Pekin, at a point where the river is about 1000 ft. wide. The bridge, exclusive of the pile-trestle approaches, is about 926 ft. long and consists of one 172 ft. 9-in. through lift span over the main channel, four 150-ft. through truss spans and two 70-ft. deck plate-girder spans. The substructure was built for double track, but the present superstructure is single track.



LIFT SPAN OF PEKIN BRIDGE GIVES CLEAR OPENING OF 150 FEET

Lift Span and Its Operation

The lift span has pin-connected trusses suspended at each end from twelve cables which pass over large sheaves at the tops of the towers. It is counterbalanced by concrete counterweights moving vertically inside the towers. The towers are so designed that, with a few alterations, they can be spread and used for double track.

The span is operated by two 52-hp alternating-current induction motors. The current is generated at the railway company's power station a few miles from the bridge and transmitted at 6600 volts to a set of transformers located in the south tower of the bridge, where it is stepped down and delivered to the motors at 440 volts. A 12-hp gasoline engine, installed for service in case of interruption to the electric power, was used to operate the bridge for about a month when it was first put into service, until electric power was available. This engine opened the bridge in 5 minutes. Hand operating equipment is also provided for use in emergencies.

The problem of providing satisfactory foundations for the piers made the substructure the controlling factor in determining the type of bridge. The conditions affecting its design were (1) the maximum depth of water, which is about 25 ft. in the main channel; (2) the character of material in the riverbed—mud, sand, clay and gravel for a depth of about 55 ft., and below this a nearly horizontal stratum of shale and rock; (3) the established grade, which was about 21 ft. above high-water level and was determined by the crossing over the Chicago, Peoria & St. Louis Railroad a few hundred feet south of the bridge; (4) the government requirement of 150 ft. horizontal and 55 ft. vertical clearance with the bridge open; (5) the depth of 15 or 20 ft. of water expected during much of the period of construction, and (6) possible future deepening of the channel by the Government in constructing the proposed deep waterway from the Great Lakes to the Gulf.

Under these conditions, the necessary height of piers above the riverbed was about 40 ft. for the channel piers, gradually decreasing to about 30 ft. for the end piers. The weight of piers of this height, together with the superimposed loads, made it necessary that the tower piers and the longer spans be carried down to rock, or that their footings be spread out over very wide pile foundations.

Comparative estimates were made of three types of piers: (1) Plain concrete with timber grillage on pile foundations, constructed by the open-caisson method; (2) plain concrete on pile foundations, constructed in cofferdams, and (3) cylinder piers of the type adopted. Numerous variations in detail were worked out in the studies of these types. The objection to piers on pile foundations was the excessive pressure on the piles, especially in the case of the high piers carrying the towers. Variations in the design to bring the pressures within the desired limits greatly increased the cost. The final result of the studies showed that the cylinder piers gave a considerably cheaper and more substantial substructure than could be built of the other type. Cylinder piers, carried down to rock, also serve better than any design possible with pile foundations, to provide for future deepening of the channel in connection with the proposed deep waterway.

Design of Piers

Four of the highest piers, with the greatest superimposed loads, were carried down to rock. For two of them the cylinders were made 15 ft. in diameter on account of the heavy vertical and wind loads from the towers. The cylinders for the other two piers were made 12 ft. in diameter, with about the same foundation pressures. The maximum pressure on the rock from direct vertical loads varies from 27,500 to 30,000 lb. per square foot for vertical loads only, no allowance being made for buoyancy, or for the friction of the cylinder against the earth. If the overturning effects of wind and tractive force were transferred direct to the foundations of the piers these pressures would be increased over 150 per cent, but it is assumed that the 50 or 60 ft. of solid material penetrated prevents most of this from reaching the foundation. The superimposed loads on the remaining four piers are much less, and by making the upper parts of these cylinders of smaller diameter and spreading the bases, it was possible to support them on pile foundations with a maximum pressure from vertical loads of 56,000 lb. per pile. The effect of tractive force increases this pressure to some extent.

The two cylinders in each pier are connected at the top by a massive concrete cross beam reinforced by two heavy structural-steel trusses which extend well into each cylinder, forming a rigid connection between them. These trusses were designed to carry the weight of the concrete cross beam and the reactions from the superstructure bearings resting on it, and are placed directly under the superstructure bearings.

The reinforced-concrete slab forming the bottom of the cross beam was built in place in a form spanning the space between the two cylinders. After the concrete in the slab had set, it served to support the concrete above it while the cross beam was being built up. Another set of reinforcing bars was placed in the bottom of the cross beam just above the slab, to provide reinforcement independent of that in the slab.

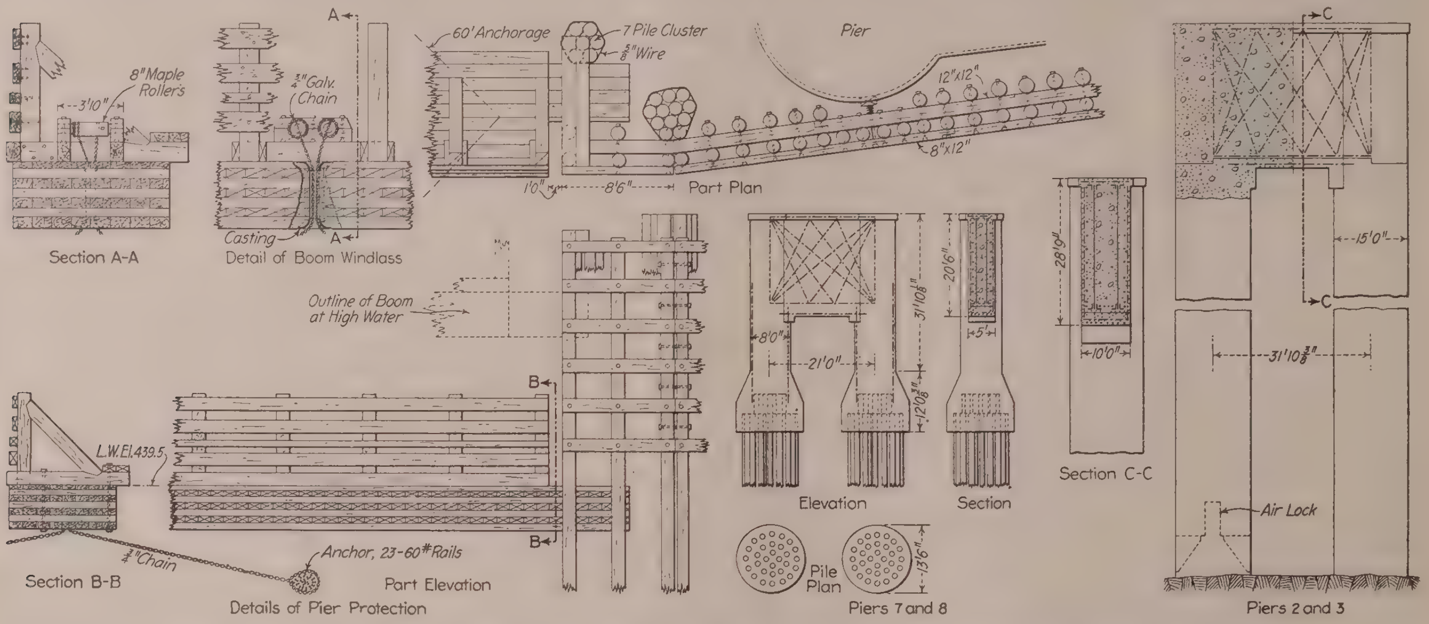
Pier Construction

The eight cylinders carried to rock were sunk by the pneumatic process. Each cylinder was sunk independently until the bottom of the pocket for the cross beam was about down to the water level. When both cylinders of a pier had been brought to this level, the form for the cross beam was put in and the two cylinders were sunk together to permanent position, carrying the form down with them. This procedure was followed to avoid working under water in placing the form.

The first 8-ft. section of each cylinder was converted into a working chamber by a steel diaphragm across the top, with an opening in the center leading to the air lock. The wall of the working chamber was stiffened by solid-web kneebraces. The bottom of the section was reinforced by an angle-and-plate cutting edge to resist crushing or bending by boulders and hard strata.

The cylinders, which were of ⅜-in. metal, were made up at the shop in sections from 5 to 8 ft. long, which were shipped to the bridge site in halves. The top section for each cylinder was not laid out at the shops until the cylinder to which it applied had been sunk to final position on rock and accurate height measurements secured.

In constructing the piers with pile foundations the lower sections of the cylinders were assembled and riveted up on shore, brought out on a barge and suspended over the completed pile foundation by timbers carried on guide piles. Concrete was introduced through the top and deposited under water to a depth of about 6 ft. When both cylinders of a pier had been sealed in this manner the form for the bottom of the concrete cross beam was placed and made watertight and the cylinders were pumped out.



MISCELLANEOUS DETAILS OF PIERS 2, 3, 7 AND 8, AND OF PIER PROTECTION, FENDERS AND BOOM WINDLASS

"PILOTING" THE CYLINDERS

The locations of the pier centers were fixed by a system of triangulation, with a base line on each shore. During the sinking of the cylinder the actual position of the center was checked once a day, or oftener. Great care was taken to place the cylinder in correct position at the start, and to prevent displacement in the early stages of sinking. Any tendency toward displacement was checked by wedging with blocks between the cylinder and guide piles driven in a circle around it; also by undermining the cutting edge on the opposite side from the wedge. These methods were effective during the early stages; very little could be done toward correcting displacements after the cylinder had penetrated hard material. It was important that the cylinder be started in correct position and guided carefully during the first half of its progress. After that there was little tendency toward displacement.

In the completed piers the centers of the tops of nearly all the cylinders were within 4½ in. of the correct position established by the triangulation. The maximum displacement was about 8 in. from the correct position. A certain amount of displacement had been anticipated and provided for in the width of bridge seats, and no difficulty was encountered in adjusting the superstructure to the completed piers.

PIER PROTECTION

The protection for the channel piers consists of a fixed section and two floating booms for each pier. The distinctive features of the protection are the floating booms extending from each end of the fixed section. The fixed sections directly in front of the piers are of the usual type, consisting of two rows of piles with horizontal wales between the rows and on the front.

The channel conditions in the vicinity of the bridge are such that long fenders are necessary to direct the traffic in the channel. Fixed structures were deemed impracticable for this purpose, as any ordinary timber structure would be carried away or wrecked when the ice goes out in the spring. The floating booms are not exposed to dangers from ice, as they remain in the channel only through the season of navigation. During winter they are parked in a safe place until the ice has gone out and navigation is about to open.

The protection for one of the piers of the lift span is shown, and that for the other pier of the same span is similar but differs on account of the skew. The face of the pier is protected by a rack composed of two lines of round piles with six 12 x 12-in. wales between them and six 8 x 12-in. wales bolted to their outer faces on the same lines. The extremities of the rack take bearing against dolphin piles.

The rack takes bearing on each pier cylinder through four spiral springs of 1 3/16-in. steel engaging the four upper main wales. These springs have a range of 1 11/16 in. between open and closed positions and are intended to absorb impact from vessels or floating objects. The elasticity of wales and of the dolphin piles also presents considerable resistance to displacement.

FLOATING BOOMS

The four floating booms have a uniform width and are from 65 to 300 ft. long. They are made of five solid courses of longitudinal hemlock timber alternating with three solid courses of transverse cedar timber, all of which are submerged, the water level being assumed at the top of the upper course. Triangular vertical transverse frames 7 ft. high are bolted to the upper course of the boom about 6 ft. apart, and are provided on the vertical face with five lines of wales forming a barrier to guide and restrict navigation.

The heavy timber base of the boom gives it the buoyancy necessary to keep the fender above the water line, as well as the necessary strength and stiffness to resist the impact of heavy boats.

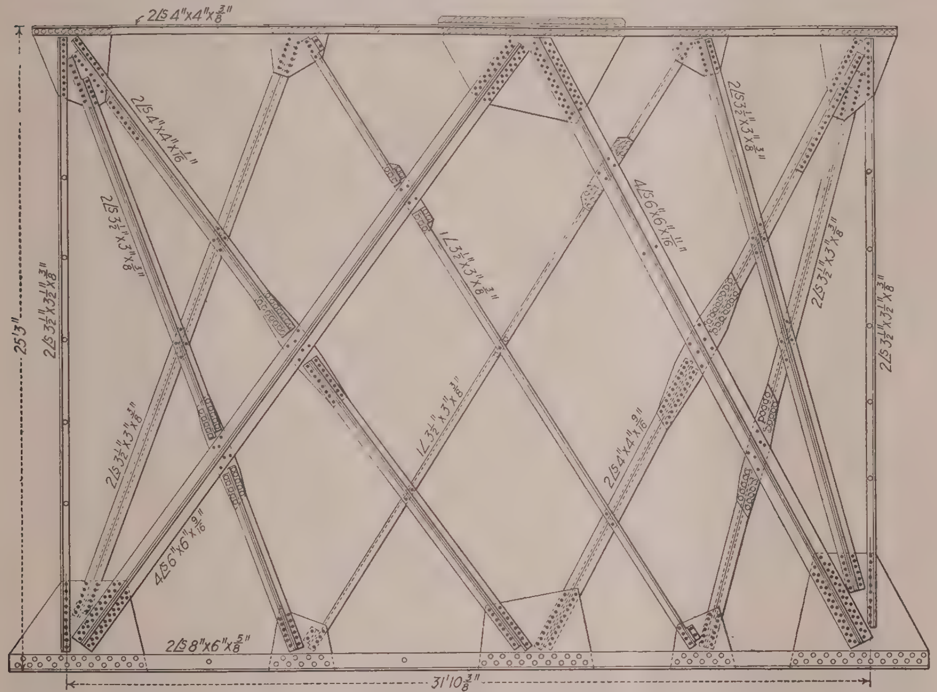
The booms are anchored with chains attached to heavy masses of old rails wrapped with chains and laid in the bed of the river. Under variations of water level the anchorages give the booms a longitudinal motion due to the change in the inclination of the anchor chains. This movement is provided for at the pier ends of the booms by extending a part of the timber base in the form of a tongue. This tongue moves longitudinally and vertically between the end piles of the fixed section on one side and a cluster of guide piles on the other, and this keeps the end of the boom in proper position relative to the fixed section.

ADJUSTING THE BOOMS

Owing to the wide variation in water levels, it was necessary to provide adjustment in the anchor chains. This was done by carrying the chains up through holes in the timber base and attaching them to hand-operated windlasses on the deck. Adjustment is required only under considerable variation of water level. The length of the anchor chain and tongue at the pier end allow the boom to adapt itself to variations of a few feet without adjustment of the chains.

When the booms are to be parked for the winter they are disconnected from the anchors and towed to the shore. The greater part of each anchor chain remains attached to the anchor. To the free end of the chain is attached a wire which is run out to the shore and fastened at some convenient point. When the booms are to be returned to service in the spring they are towed out and moored in position by a tug; the anchor chains are picked up with the wires running to the shore, and are connected to the boom, and the lengths are adjusted to the water level by the windlasses on the decks.

The substructure and all of the superstructure except the lift span and towers were designed in the engineering department of the Chicago & North Western Railway when E. C. Carter was chief engineer, W. H. Finley (now chief engineer), assistant chief engineer and W. C. Armstrong, engineer of bridges. The lift span and towers were designed by Waddell & Harrington, of Kansas City, Mo. The Missouri Valley Bridge & Iron Company, of Leavenworth, Kans., was the contractor for the substructure. The King Bridge Company, of Cleveland, supplied the structural material of the superstructure, and Geo. P. Nichols & Brothers, of Chicago, the machinery and electrical equipment. The entire superstructure was erected by the Kelly-Atkinson Company, of Chicago. H. M. Spahr was resident engineer in charge of all field work for the railway company.



HEAVY STRUCTURAL-STEEL TRUSSES REINFORCE THE CONCRETE CROSS BEAMS AT TOPS OF PIERS, ILLINOIS RIVER BRIDGE

Costs per Capita for the several parts of the sewage-treatment plant at Fitchburg, Mass. (see Engineering Record, June 7, 1913, page 633), were given by David A. Hartwell in a paper before the Boston Society of Civil Engineers, March 3. As the matter of excavation depends upon the location and conditions and would vary widely, Mr. Hartwell has eliminated all such cost in the following figures. The cost of the five Imhoff tanks was $52,224 which, based on a population of 55,000, would be about 96 cents per capita. The cost of the sprinkling filter, 2.14 acres in area and from 10 to 10½ ft. deep, was $122,990 or $58,847 per acre; based on a population of 40,000 the cost was $2.94 per capita. The cost of the sludge-drying beds when completed will be about 5 cents per capita. The cost of the secondary tanks was $8426, or about 15 cents per capita for a population of 55,000. The cost of the dosing tank was $9436, or 17 cents per capita. When completed the disposal works will cost about $320,000, including cost of land, buildings, roadways and incidental work not including engineering and inspection. The cost of the latter has been 8½ per cent, which would add $27,200 to the cost, making $347,200 or $6.31 per capita.

Detroit's Urban Transportation Needs—Present and Future—Set Forth

Engineers' Report Proposes Rerouting of Cars for Immediate Relief and Preparation for Ultimate Construction of Subway

Various measures for relieving the street railway traffic congestion in Detroit, from inexpensive temporary expedients, such as the use of skip-stops, to the construction of a $16,300,000 subway, are suggested by Barclay Parsons & Klapp, consulting engineers, of New York City, in an exhaustive report just made to the Board of Street Railway Commissioners of Detroit. Briefly, the report proposes that present expenditures be confined to alterations in existing surface facilities—inexpensive makeshifts, such as the running of two-car trains, the skipping of stops and the putting on of extra collectors at the front ends of Pay-as-you-enter cars, these to be followed by the construction of certain loops and short connections to make possible a complete rerouting of the cars to avoid a number of badly congested crossings. These changes, the engineers think, would give an average increased capacity of about 40 per cent.

At the same time the rapid growth of population of the city makes it probable that other relief will be needed in the comparatively near future, and the engineers, therefore, urge the immediate adoption of a definite subway policy. They propose a subway in Woodward Avenue, the main north-and-south artery of traffic, with a loop at the Detroit River. Only a short section of subway would be built at first, extending from Grand Circus to the river and, like the original Boston subway, used only by surface lines coming in from beyond the portal. It would, however, be designed for special subway trains, and would ultimately be extended in Woodward Avenue to the city limit, a distance of about 6 miles.

A separate study was made of the traffic congestion at the junction of the Grand Boulevard and Jefferson Avenue, whence a bridge leads to Belle Isle Park. To avoid interference between the regular travel on Jefferson Avenue and the holiday crowds going to and from the park, the engineers propose an underpass for vehicles from the boulevard to the bridge approach, and the replacement of the existing bridge with one on which through cars could be routed across to the island and to an underground station which would not mar the appearance of the park.

The report is a cloth-bound volume of 291 pages, supplemented by numerous maps and drawings. Its substance is given in the first thirty pages, which comprise Part 1. The remaining pages go into the various phases of the matter in detail. These notes are taken from the report.

Conditions in Detroit

Detroit is essentially the city of individual residences, and few suburbs. Its growth since 1900 has been rapid, and this fact has begun to manifest itself in the replacement of the individual dwelling by the apartment house. During this period of rapid growth the city has become more markedly a manufacturing city, and the factories are widely scattered. The report divides them into eleven groups, which are scattered throughout the city. The 45,000 employees are also scattered throughout the city, and while 13,000 of them are within walking distance of their factories and 20,000 use street car transportation outside of the congested district, 12,000 travel twice a day through the heart of the city.

As previously stated, the main north-and-south artery is Woodward Avenue. Most of the north-and-south car lines use this thoroughfare, and a large part of the east-and-west traffic crosses at grade at Michigan Avenue, in the heart of the business district. There is also a heavy cross traffic at Jefferson Avenue, near the river, and considerable at several other points. Besides these direct crossings, other cars turn in and out at these street intersections counter to the general direction of the main traffic. In addition there are heavy vehicular and pedestrian movements, including an unusual number of privately owned automobiles.

Immediate and Ultimate Relief

The measures proposed for immediate relief are given in the summarized recommendations. As previously stated, it is believed that they would effect an average added capacity of the existing lines of 40 per cent, although it is thought that a 50-per cent increase would be made possible on Woodward Avenue. These changes would remove the immediate necessity for a subway. If the present rate of growth is maintained, however, the population of the city and suburbs will reach the 1,000,000 mark by 1920 or shortly thereafter. A subway suggests itself as the means of accommodating the increased travel, and Woodward Avenue is the obvious thoroughfare for such a subway. A long subway, that is, one of sufficient extent to warrant operation as a separate unit with special subway trains, in this case extending to Manchester or Victor Avenue, would cost about $16,300,000. Transfers to and from the surface lines would probably be demanded at the regular five cent fare, and it is doubtful whether there would be sufficient travel to make the investment pay.

Meanwhile it is probable that within six years the traffic will be almost double, so that even with the increased capacity gained by rerouting the cars it will be necessary to provide means for permitting more cars to reach the congested area. A solution of this problem would lie in the construction of a subway loop for street cars such as would form the proper terminal by a subway line on Woodward Avenue. This short section, although designed primarily for the operation of street cars, should be of proper dimensions for later use by subway trains. While such a subway would have little earning capacity, it would, nevertheless, be of relatively small cost, probably about $2,500,000. The investment would be of general benefit to all of the traveling public of Detroit, and would be a logical step following the proposed complete rerouting of the present lines.

SUMMARIZED RECOMMENDATIONS

Summarizing, Detroit's street railway rush-hour problem is essentially a case of unusual traffic concentration, due to a system of converging car lines loading and unloading the bulk of their passengers in a very limited central delivery district. It is believed that immediate relief can be obtained from the bad rush-hour conditions and a permanent improvement effected by bringing the existing surface lines up to their maximum capacity and securing the greatest freedom for their movements in the congested district. The thirteen recommendations for improving existing facilities are divided into two groups, A and B.

Group A.—This group includes the recommendations contemplating a complete rerouting of the existing car lines, the addition of new bridges and short sections of new tracks, the addition of new equipment and the expansion of certain of the lines. In condensed form they call for:

1. A system of loops to eliminate as far as possible the present crossing interferences. (The appended diagrams show the complete elimination of crossing movements at the worst point, the intersection of Michigan Avenue and Woodward Avenue, and a great reduction in the direct crossings and conflicting switching movements at other points.)

2. Two-car units on Woodward Avenue and some of the other heavier lines during rush hours.

3. Additional car service on the lines at present overcrowded, and the use of larger units on some of the lines now using the older types of cars.

4. Expansion of the existing Crosstown, Fourteenth, Warren and Grand belt lines.

5. The building of a larger bridge at the present site for handling heavy traffic to Belle Isle, and provision for the operation of through cars to the island.

Group B.—This group covers improvements designed to give immediate relief, which can be put in effect at once without material expense. They are:

6. Systems of stations or skip-stops.

7. The employment of street collectors to load at the front doors of cars during the rush hour in the downtown district.

8. The removal of the division rail on the rear platform of the pay-as-you-enter cars.

9. The running of special cars without stop through the crowds of factory workers at certain times of the day to care for the general travel.

10. Provision for special streets for vehicle travel, by improvements in paving, lighting and widening of these streets. Ordinances to give right-of-way to vehicle traffic on these special streets to encourage automobiles to use them.

11. An ordinance for stopping automobiles with the street cars on Woodward Avenue facilitates safe and rapid loading and unloading of the cars.

12. Rigid parking regulations at the ends of the blocks near the safety zones.

13. Temporary rerouting on certain lines pending the completion of track changes.

Subway.—To provide for the handling in the future not only of a much greater volume of traffic than at present, but also one of greater density, the following measures are recommended:

14. The taking of immediate steps to procure all necessary enabling legislation and permit the prompt execution of whatever subway policy may be adopted.

15. The preparation of detail plans for a short subway loop at least two years in advance of the necessity for such subway.

16. The design of this loop with a view to ultimate use by special trains for rapid transit service, when the construction of a long subway is warranted.

17. The adoption of a general subway policy outlining the city's position as to the building and financing of subways, this policy to include a decision as to whether the subways are to be built on the city's credit as public improvements, in anticipation of traffic conditions which would make them attractive, self-supporting projects for private investment.

Some Factors in Painting Structural Steel

Designing for Future Maintenance—Effects of Methods of Applying Paint

ONE factor in the design of steel structures that is frequently overlooked is the necessity for so detailing and selecting main sections that painting and maintenance can be effectively provided for. It should generally be found possible to so design almost any structure that inspection and painting are relatively easy, and thus insure the longest life for the structure consistent with the given conditions. This suggestion while not new is one of the points upon which H. Lowe laid emphasis in a recent paper entitled "Some Paint and Painting Factors," presented before the Municipal Engineers of the City of New York. Several significant parts of this paper are here abstracted.

TOUCHING UP THE NAKED SPOTS

Simplicity of construction is one of the chief objects to be desired, yet it may not prove possible to so design that every part can be inspected and maintained. However, if any part is inaccessible so that it cannot be coated with paint and protected, decay or corrosion must take place and increase. All complicated details, such as depressions, horizontal pockets, cracks, crevices, etc., in which dirt and water may collect should be avoided as far as practicable. Every part should be so designed that it can be examined, repaired and painted. If necessary, special facilities, such as examination, platforms, ladders, etc., should be provided.

Engineers frequently waste money through repainting the entire structure at short intervals. As paint fails more rapidly on the sunny and the exposed sides of a structure, it would pay to clean and touch up these sore and naked places when needed, and let the healthy parts alone. Anyone who desires to be a competent judge of the workmanship of painters must himself know how to handle a paint brush, as almost any painter can fool even a shrewd amateur who is standing over him. Look well to the joints, fittings, contact surfaces and hidden parts that water may be excluded from them. In the use of paint, much depends upon where it is used, when it is used, and the man who uses it.

NUMBER OF COATS AND THEIR SEQUENCE

One coating of any good oil paint will form a skin about 1/500 in. thick over a smooth non-absorbent surface such as naked steel. As all paint films are more or less permeable to moisture it is obvious that one coat is inadequate to inhibit the corrosion of a steel surface; in fact, it is too tender even to withstand the erosive effects of wind and rain. A paint skin closely resembles animal epidermis; the vital distinction between the human skin and a paint skin being that the former has the power of renewing itself, while the latter has not.

If a painted surface is seemingly dry in one day it is best to wait, to be safe, four days before re-coating it. This will insure not only satisfactory drying, but such hardening of the layer that it is in fit condition to receive another coating.

NATURE OF THE DRYING PROCESS

The drying of oil paints may be described as a sort of breathing process; the oil must inhale or take on oxygen from somewhere, and it must exhale or give off carbon dioxide and water, else it cannot dry. A gallon of oil gradually gains about one-half pound in weight in drying, then much more slowly loses in weight until decomposed. Maximum power to resist atmospheric influences is attained at maximum weight, but no definite time can be set for this because it depends upon various factors.

Powders may be added to the oil to increase the rate of oxidation, but none of them, such as lead and manganese compounds, can make it dry fast enough. Hence the resort to japans, i.e., substantially insoluble soaps. These soaps, if well made, improve oil paints; if poorly made they lessen their value, shorten their life and burn them up.

In conclusion, the importance of proper classification of our knowledge, of selective grouping of facts and careful study of their relations in order to reach true conclusions, should be emphasized. Some of the technical features in paint making and paint using as related to the practical problems of the engineer have here been outlined. Important as these are, they will not insure the best results unless controlled by the more significant factor of confidence in the makers and users of these products upon which the life of steel structures depends.

A PRACTICAL NAVIGABLE CHANNEL from the Bering Sea into the mouth of the Kuskokwin River in Alaska has been discovered, thereby opening to commerce the second largest river in the Territory.

Concrete "Bleachers" Protect Massachusetts Shores

Defense Works at Revere Beach Reservation in Boston Have Been Designed to Break Up Force of Wave Impact and Prevent Encroachment by Sea

REINFORCED-CONCRETE steps 30 ft. wide, known locally as "bleachers," serve to break the impact of the waves along Revere Beach, near Boston, Mass. This marks the first application in this country of the ramp principle to structures of this kind, although to some extent it has been employed in England. The total length of the ramp is about 1500 ft. and it contains seventy-one 21-ft. sections separated by expansion joints.

The erosion of the shore at Revere Beach has given the Metropolitan Park Commission great concern. The parkway runs on a narrow ridge between the ocean and a marsh. The waves constantly cast up shale, shingle and sand, which help to maintain the ridge, but the same waves also pound the ridge to pieces. Wooden piles and bulkheads have been employed from time to time to check the sea, but they decayed rapidly and did not withstand the bombardment of a storm. Many times, therefore, the boulevard, which makes an important link in the Boston chain of parkways, has been damaged. The elevation of the road is about 18 ft. above low water.

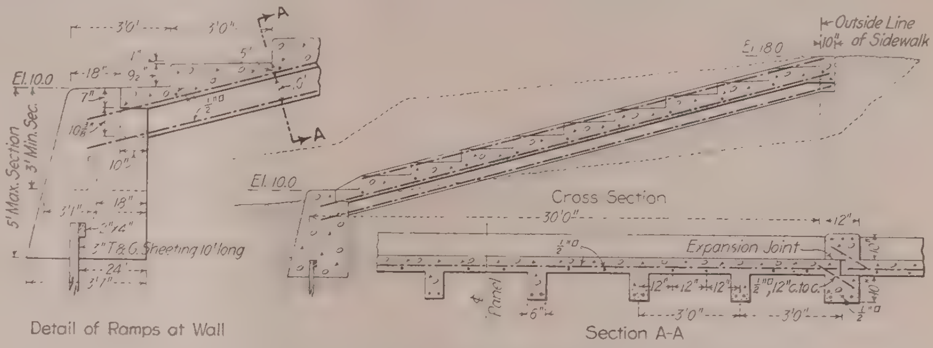
When a permanent protection was considered the ramp principle was discussed, as the ramps divide the waves, thus distributing the force of the blows. This is not the case with an ordinary sea wall, which must stand the whole force of the sea at a single blow. Such walls, therefore, must depend upon weight only to resist the impact, thus making their construction very expensive.

EXPANSION JOINTS

In the accompanying drawings is shown the design of the ramps. Reinforced-concrete steps, with 3-ft. treads and 9½-in. risers, having a minimum thickness of 5 in., are built on 6-in. wide reinforced-concrete sills 10 in. deep running normally to them. These sills are spaced 3 ft. on centers and every seventh is 12 in. wide. At those points are located the expansion joints. To prevent the water from penetrating the panels at these joints they have been covered by 10 x 12-in. reinforced-concrete caps, so that the expansion joints are Z-shaped.

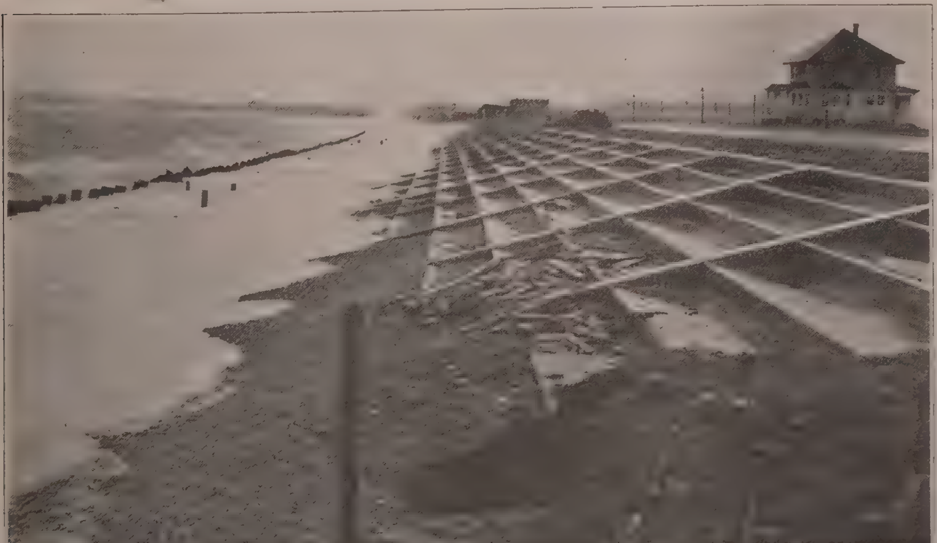
At the upper end of the steps a curb 10 in. wide has been provided. At the lower end the sills and the lowest step have been built into a concrete gravity-section retaining wall and anchored to it by the extended reinforcement. The retaining wall, which varies in depth from 3 to 5 ft. and is built over a 3-in. tongue and groove wooden sheet piling 10 ft. deep, serves to prevent the water from eating away the ground underneath the ramps. The concrete used in building the ramps was a 1:2:4 mix.

The design was prepared under the direction of John R. Rablin, engineer of the Metropolitan Park Commission, Boston.



DETAILS OF REINFORCED-CONCRETE BLEACHERS AT REVERE BEACH

THE PRODUCTION OF PIG IRON in the United States in 1914 was 23,332,244 tons, a decrease of 24.6 per cent as compared with the record figure of 1913, according to a bulletin issued by the Bureau of Statistics of the American Iron and Steel Institute. The output was in fact less than in any other year since 1908. Every grade except forge pig iron, which constitutes less than 2 per cent of the entire production, showed a decrease. The falling off was practically uniform in the different States, the outputs of the two greatest producers, Pennsylvania and Ohio, being respectively 41.72 and 22.64 per cent of the total, as compared with 41.84 and 23.02 per cent in 1913. Basic and Bessemer pig iron constituted 41.45 and 33.68 per cent respectively of the entire production in 1914, as compared with 40.48 and 37.43 per cent in 1913.



FLIGHT OF CONCRETE STEPS, 30 FEET WIDE, PROTECTS REVERE BEACH

Drag-Line Excavators with High-Duty Machinery

Four-Yard Bucket Machines Operated by Electricity and Compressed Air for Work on the Little River Headwater Diversion Channel

FOR the protection of about 500,000 acres of land now subject to floods in the head waters of the Little River Drainage District in Missouri, there is under contract a diversion channel 30 mi. long which in some places has a depth of 18 ft., a bottom width of 113 ft. and side slopes of 2:1. It is expected that about 7,000,000 cu. yd. of the excavation involved will be done by dragline excavation machines installed on longitudinal tracks of the original surface of the ground and operated from the shore of the Mississippi River to a point about 13 mi. away. Under favorable conditions each excavator is expected to handle 2000 cu. yd. of earth in one 10-hour shift, depositing it in final position in a spoil bank 18 ft. high, beyond the 40-ft. berm, on which the machine will travel.

These machines are notable for their great size, capacity and rapidity of operation, for the special turntable construction, telescopic current-transmission joints, improved application and arrangement of electric and compressed-air controlling devices, and for the self tracklaying facilities. The method of operation includes the preliminary construction and control of a pilot ditch to drain the swampy land, and the transfer of the machines across the high Government levee on falsework.

GENERAL CONDITIONS AND OPERATION

The general character of the work on which these machines will be employed was described in the Engineering Record of Aug. 22, 1914, page 204. It forms an important part of the $4,000,000 flood-protection and drainage system being executed for the improvement of a 10 x 90-mi. tract of alluvial land in the Little River Drainage District. The location of the work is largely through swampy land, much of it submerged to a depth of several inches most of the time and in many places covered with a heavy second growth of timber.

The machines were erected in the bottom land within about 4500 ft. of the banks of the Mississippi River, on soft swampy ground which is to be drained by a pilot cut before the drag-line excavators are put in operation.

During the progress of the work the Mississippi River is likely to have frequently a stage intermediate between normal and bank full that would back up through the pilot cut, a contingency which will be safeguarded against by the construction of timber outlet gates that can be closed during periods of high water and opened when the river falls sufficiently to permit the discharge of the accumulated drainage above the gate.

The work will be started near the Mississippi River at a point perhaps 200 ft. from the shore, and will eventually cut through the existing Government levee, but this will not be done until all the work in shore of the levee is completed. Hence it will be necessary to transport the heavy machines over the levee on falsework and install a small centrifugal pumping plant to carry the drainage water across. After the completion of the channel about 1500 ft. of the Government levee intersected will be removed.

The embankments will have a 6 x 8-ft. exploration or muck ditch which will be carried to whatever additional depth may be necessary to cut off under seepage, and where well defined channels are encountered the exploration ditch will be supplemented by a cutoff wall of concrete or sheeting.

TYPE OF MACHINE

The machine, which is known as a Class M, Lidgerwood drag-line excavator, weighs about 190 tons, including the 100-ft. 34,000-lb. steel boom. The excavator, together with the operating machinery, is installed on a heavy steel platform mounted on a turret-type turntable 24 ft. in diameter, provided with rack-and-pinion swinging gear which enables it to revolve continuously through a complete circle. The machine is carried on four four-wheel compensating arch-bar trucks of 36-in. gage running on seven sets of track sections 15 ft. long, which, when the machine is to be moved, are rapidly picked up in the rear by the boom, swung 180 deg. and placed in front ready for the machine to advance. For this operation hooks are connected to the scraper bucket, and handle the track sections without delay in making or removing connections.

The 4-yd. scraper-type Page bucket has a lip and teeth of manganese steel. It is handled by a 1¼-in. Hercules cable which with the nine-part boom topping lift is operated by a Lidgerwood special elevator engine driven by a 225-hp General Electric motor. The boom is arranged to operate a clamshell or an orange-peel bucket by the simple addition of another sheave at the end.

The turntable is revolved by bevel gears mounted on a 9-in. vanadium-steel vertical shaft. The brakes for the swinging engine as well as the frictions for the bucket operation are operated by compressed air. The air compressor is driven by a 15-hp motor and the swinging gear by a 112-hp motor. The controls for the bucket and swinging motors are of the magnetic master type, designed to protect the motors and insure their maximum efficiency. The machine is counterbalanced by 20 cu. yd. of concrete placed in the rear of the upper platform and serving as a flooring. Each machine is provided with a 15,000-candlepower electric light for illuminating the working radius of action of the excavator and permitting work to be carried on at night.

ELECTRIC CURRENT AND OPERATION

The 440-volt three-phase 60-cycle alternating current by which the machinery is operated is delivered by the Missouri Utility Company through a 30-mi. auxiliary transmission line installed by the contractor as the work progresses along the right-of-way line. From this line the current is stepped down to 440 volts by a transformer carried independently of the machine on a small truck connected to it by 400 ft. of cable, and thus permitting 800 ft. of excavation to be made before transformer connections are changed. The current is delivered to the machines through stationary brushes engaging a vertical post in the axis of the turntable, which is fitted with a telescopic joint providing for irregularities of position and for continuous circuit whatever the position of the machine. Each machine is operated by a crew of four men in addition to an electrician; they are a runner, an oiler and two pit men. The crew will probably be brought to work daily by gasoline motors operated over the railroad from Cape Girardeau, Mo.

Normally the bucket is dumped while the boom is continuously swinging through a full circle at an approximate rate of one revolution per minute. In trial tests complete revolutions have been made in thirty seconds and the bucket has been filled, emptied and returned in forty-five seconds. It is estimated that under favorable circumstances the machine can handle one bucketful per minute continuously.

The work is being executed under the direction of William A. O'Brien, chief engineer, Little River Drainage District.

Screw Spikes Give Satisfaction on Delaware, Lackawanna & Western Railroad

G. J. Ray Presents Observations and Precautions for Applying, Based on His Company's Five-Year Experience with Them

SCREW SPIKES have been used extensively on the Delaware, Lackawanna & Western Railroad, both in new construction and in the maintenance of old. In describing at length in the March "Bulletin" of the American Railway Engineering Association the company's experiences, G. J. Ray, chief engineer, admits that some mistakes were made at first, and that later developments may change some of the present practice. As a whole, however, he states that the screw-spike installation has proved very satisfactory, and no conditions have developed such as to cause any doubt as to the ultimate success of the undertaking. Numerous minor difficulties anticipated have not materialized. On the other hand, the screw spikes have in numerous cases shown up very favorably as compared with cut spikes.

Quoting Mr. Ray, "It was fully expected that no small amount of trouble would be experienced from derailments, changing out broken rails, difficulty in gaging track on sharp curves, etc. It is a pleasure to state that, to the writer's knowledge, we have never had a derailment where the screw spikes have not been very much less damaged than the cut spikes in the same locality, and very seldom has a derailment broken off any screw spikes or damaged them to such an extent that they did not continue to firmly hold the rail in place. We have had many cases of derailment where it was not necessary to remove a screw spike, whereas nearly every cut spike on the damaged side of the rail was destroyed. Again, we have had some derailments where it is reasonably certain that bad accidents were prevented by screw spikes in some of the ties holding the rails in position, whereas the cut spikes in the other ties were destroyed. With the first tieplates used, without supports for the spike heads on the inside of the rail, we did have some spikes badly bent by derailed wheels, thus causing no little delay in their removal. We have as yet had but few cases with screw-spike construction where the tracks have been found to be wide gage, due to spreading the rails, and all such cases have been on sharp curves, where shortleaf yellow-pine ties were used in renewals and where only a few screw-spike fastenings were placed per rail length.

"It should, of course, be understood that there are some exceptional places on the railway where any metal parts, irrespective of whether they are cut spikes, screw spikes, bolts, etc., even when thoroughly protected and reinforced by channel plates or other devices, will be cut off or will fail to hold track, but such exceptional cases should not be taken as evidence of the success or failure of any holding device. On the other hand, we have many cases where the rails could no longer be held to safe gage with cut spike fastenings, when the installation of screw spikes and a flat-bottom tie plate has not only made safe track, but materially lengthened the life of the ties, bridge and switch timbers.

"As to relaying rail, or removing broken rails, it is to be expected that more time will be consumed in doing the work. In other respects the conditions are no different from those experienced with cut spikes."

Mr. Ray's discussion, with the illustrations, occupies 64 pages of the "Bulletin" and embraces many phases of the subject. He explains the reason for the adoption of screw spikes, which was the necessity for something to grip the tie to maintain gage on sharp curves, and the desire for something that would not damage the wood fiber as flanged tieplates were found to do. The details of the tieplates, spikes, appurtenances and machinery for applying in present use have been evolved, as he shows, from earlier experiences. Labor costs in connection with the construction of the Lackawanna Railroad of New Jersey, amounting to a mileage of approximately 60 mi. of main track, are given as follows:

	Per mile
Cost of boring by hand in the field, 2,880 ties at 3.5 cents	$100.80
Cost of applying 11,520 screw spikes at 1.9 cents	218.88
Cost of laying track, less boring and placing screw spikes at 8.5 cents per foot	448.80
Cost of surfacing 5,280 ft. of track at 17 cents per foot	897.60
Average cost of labor per mile of main track	$1,666.08

The following general conclusions as to screw spikes, and precautions to be taken in applying, are based on the experience of more than four years.

TIES

1. Treated beech, birch, gum, hard maple, elm and probably other similar woods may be safely used with oak on

sharp curves where the traffic is especially heavy.

2. From an economic standpoint, softwood ties, such as loblolly pine, should not be used on tracks of excessive traffic, nor is it advisable to use them on sharp curves with moderately heavy traffic. An expensive fastening device, such as an extra large and heavy tieplate or chair, securely fastened to the tie by fastenings independent of the spikes securing the rail, with sufficient room for rail movement on the tieplate, thus reducing the movement between plate and tie to a minimum, would probably make it practicable to use softwood ties on straight track and light curves with moderately heavy traffic. It is not believed, however, that loblolly pine, or similar ties, can be economically used with good results on heavy curves, regardless of the style of fastenings.

3. As a rule, with woods which it will pay to treat, the poorer the quality of the timber the more elaborate and expensive the fastening must be if the mechanical life of the tie is made to approach the life of the treated timber.

4. The hardest track to maintain, from a tie standpoint, is on sharp curves, elevated for high-speed trains, where the speed of freight trains is restricted on account of grade conditions. Where traffic is especially heavy, such curves should be provided with the best of hardwood ties.

TIEPLATES

1. Tieplates should be used on all ties where screw spikes are used.

2. The tieplates should project well beyond the base of the rail on the outside and less on the inside to counteract the tendency of rail to roll out.

3. As a rule the required thickness of the tieplates will depend upon their projection beyond the base of the rail, and the traffic.

4. Four holes should be provided for screw spikes, so that two extra holes will be available if needed.

5. All holes should be punched from the top down and be as neat a fit for screw spikes as consistent, so as to make all screw spikes act together in resisting lateral pressure. The outside screw spikes should be so protected by the shoulder on the plate as to prevent the rail base from cutting into the screw-spike neck; otherwise, in case of derailment and slued ties, it will be found impossible to remove the spikes without first straightening the ties.

6. A raised lug, or shoulder, both inside and outside of the rail base, should be provided to give support to the screw-spike heads. This shoulder assists in holding gage and materially reduces the breakage of spikes and damage to track in case of derailment.

SPIKES

1. The size of screw spikes and the design of the thread should be carefully considered before a screw spike is adopted. Thereafter no changes should be made; otherwise the new screw spikes cannot be used in old holes without damaging the wood fiber.

2. Where salt brine drippings are excessive, screw-spike heads must be made sufficiently large; otherwise there may be difficulty in the future in removing the screw spikes from the track, due to corrosion. During nearly five years' service no screw spikes have been found that were rusted within the tie, and there was no rust to speak of below the head, although some spike heads were rusted so badly that they could not be removed with the standard tool.

3. The screw-spike head should have tapering sides to prevent turning in the wrench socket after the size of the head has been diminished by rust.

4. Any mechanical device for setting down screw spikes must automatically release when the screw spike is seated; otherwise the screw spike is apt to be damaged in case of hardwood or the wood fibers destroyed in case of softwood.

5. Very little trouble is experienced by screw-spike heads breaking off, either on account of track movement or derailed equipment. The heads are, at times, damaged to considerable extent by derailments, but as a rule the spikes are not broken, nor is their holding power affected. Where screw spikes are broken off, a device for extracting the broken portion from the old hole without injury to the wood threads would be a valuable appliance.

6. When screw spikes are fully seated, no further strain should be put on them, as this will tend to destroy the threads in the wood or injure the spikes.

HOLES FOR SCREW SPIKES

1. All ties should be bored at the treating plant before treatment. This can be done while the ties are being adzed, and not only insures that the holes are bored sufficiently deep, but provides for good treatment of all wood adjacent to the spike holes.

2. Where the ties are bored before treatment, the track must be to proper gage before the ties can be placed.

3. The holes for screw spikes should be of proper dimensions for the class of wood used, with due regard to the size of screw spike used.

4. A limited number of holes can be bored with one bit, after which its size will diminish so as to make it unfit for a hole of a given size.

5. Holes should be bored somewhat deeper than the length of the screw spike. There is no serious objection to boring the holes clear through the ties.

GAGE

1. With oak, birch, hard maple, gum or longleaf yellow-pine ties, gage can be maintained with a flat-bottom plate, using two screw spikes on straight line and two or three on curves.

2. Heavy curves elevated for high speed, where heavy freight trains move at a slow rate of speed, are the hardest track to keep to gage.

3. Double spiking should be done on the inside of the rail.

4. Not only is the lateral and vertical resistance of a screw spike greater than that of a cut spike when both are first applied, but the lateral and vertical resistance of a loose screw spike is considerably greater than the lateral and vertical resistance of a loose cut spike.

5. When the threads in the tie are entirely destroyed, a screw lining (any one of several different varieties) may be used with good results.

GENERAL

1. All ties should be bored and adzed before treatment. This insures good gage, a perfect bearing for the tieplates and good treatment under the rail seat and around the screw-spike holes.

2. In placing screw spikes, they should be driven by hammer only sufficient to make the threads take hold. If rigid instructions are not carried out, laborers will continually overdrive spikes and thus destroy the wood fibers near the top of the holes.

3. Screw spikes with flat-bottom plates on hardwood ties will hold track to gage on sharp curves under heavy traffic. The holding power of screw spikes in hardwood ties, after more than four years' service, is not materially reduced.

4. No screw spikes have ever been found so loose that they could be easily pulled out of the holes, and but few have been discovered which could be as easily extracted as a newly driven cut spike. In no case, except with loblolly pine ties, has the threads in the wood been found weakened.

5. Screw spikes in maintenance work can be most economically used where all rail is of a standard pattern, so that regaging of track is not necessary in relaying rail.

6. Slight irregularities of track when frozen are liable to throw an excessive strain on screw spikes where there are but a few mixed with cut spikes.

7. The best results with the screw spikes can be expected in new construction, and where the number of screw spikes in tie renewals predominate over cut spikes.

8. In relaying rail, cut spikes should never be driven in old screw-spike holes, if the holes are to be again used for screw spikes.

9. No effort should be made to draw up a low tie with screw spikes when the roadbed and ballast are frozen solidly.

10. Screw spikes do not have to be continually set down, as do cut spikes, but should be gone over and set down properly after the plates are seated in the tie.

11. Flat-bottom plates with raised shoulders or lugs for the screw-spike head make but little noise and do not rattle at all where ties are adzed before treatment.

12. It cannot be expected that the full life of all creosoted softwood ties, such as loblolly pine, will be realized without providing expensive fastenings from the start, and then it will probably be necessary to add some further device at a later date. Probably the most practical and least expensive device will prove to be one or the other of the lining devices to be placed in wornout spike holes.

13. The use of screw spikes for the past five years has not made it necessary to increase the number of sectionmen per mile of track.

14. Whether or not it will pay to use screw spikes will depend on the cost of ties, their probable life and the traffic.

INDIVIDUAL METERS VS. DISTRICT METERS to prevent water waste was the subject of a paper by R. O. Wynne-Roberts at the meeting of the Illinois Section of the American Waterworks Association, March 9-11. Considering the financial situation in a typical city of 10,000 inhabitants he estimates that the cost of operating individual meters is $11,900 annually, the saving in fuel $1200 and the value of the water saved $1277. With district meters the operating cost is $5400, fuel saving, $1800, and the value of the water saved, $1914. The difference between the estimated cost of operating the two ways and the savings effected are $9423 and $1786, respectively. The extra costs per water-paying consumer per annum are respectively $2.70 and 25 cents.

Hollow-Tile Partitions and Floor Arches Tested

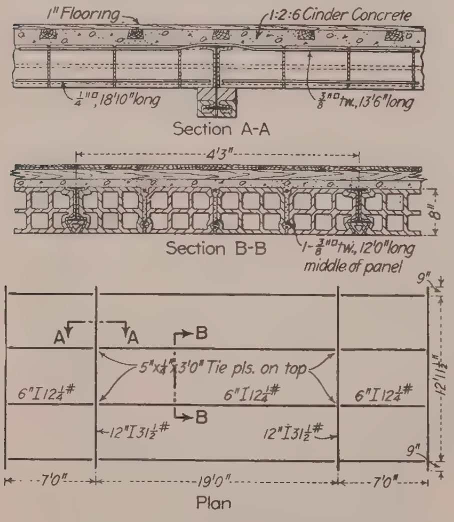
Fire Test Applied to Partitions and Load Tests Upon Various Forms of Floor Construction Show Good Results

RECENTLY completed tests upon hollow-tile construction have been reported by R. W. Hunt & Company to the National Fire Proofing Company, Chicago, showing satisfactory results for both the fire-resisting value of plastered partition walls of hollow tile, and the load-resisting value of floor arch tile with steel reinforcement. These tests, witnessed by R. W. Hunt & Company's representatives, were conducted under the auspices of the National Fire Proofing Company at their testing laboratory for the purpose of demonstrating the fire-resisting properties of hollow tile, and to obtain values of the uniform loads that could be carried by flat-arch construction of continuous beam type with deflections well within the building-code requirements.

Tests of three hollow-tile slabs about 3 ft. wide and 7 ft. long, acting as simple beams, were also made to determine the effects of adding (a) reinforcing steel and (b) a top layer of stone concrete. The arch-tile slab without reinforcement gave only nominal resistance to load; failure occurred at about 800 lb. central load, which corresponds to about 80 lb. per square foot equivalent uniform load and about 40 lb. per square inch extreme fiber stress. The danger of using flat-arch floors without reinforcing, tie rods, or other means of developing true arch action is thus strikingly emphasized by this test.

FIRE TEST OF PARTITION WALLS

Partition walls were constructed of 12 x 12-in. Natco hollow tile, openings vertical, with courses separated by horizontal channel tile through which passed two ½-in. reinforcing rods. Two walls were built, one of 4-in. and one of 8-in. thickness, and a fire chamber built around them using 4-in. walls between typical building floor construction. Vertical reinforcing rods ½ in. in diameter spaced 2 ft. 6 in. apart were also used, the tile breaking joints as far as possible without interference with these rods. A coat of Imperial plaster about ⅝ in. thick was applied to both sides of all walls.



STEEL FRAME AND FLOOR DETAILS

Test loads applied over entire surface. Support at the 12-in. I-beams gives continuous span with cantilever ends.

The test was planned to follow the standard fire test of partitions as recommended by the American Society for Testing Materials. The actual temperature averaged higher than 1800 deg. Fahr. for the last 1½ hr. of the test. Water from a 1⅛-in. nozzle at 30 lb. pressure was then applied for 2½ min., through an opening in the side and for 3 min. from the top. The outside face of the exterior wall showed small hair cracks at a temperature of about 60 deg. when the inside temperature was 1600 deg. Fahr. These cracks, due to vertical expansion, became more marked and finally appeared at all horizontal joints. The interior walls, examined the day after the test, showed about 60 per cent of plaster surface removed by the action of the water, and about 25 per cent of the tile contained fine hair cracks. A few had the dovetails broken off, and five tile had scaled off slightly, but extremely little damage was found on either the interior or exterior walls.

FLOORS FOR LOAD TEST

The accompanying figure shows the construction of the continuous floor panels, the sections being drawn for the type of floor used in the second test. Three types were tested: first, the 12 x 12 x 8-in. Natco arch-tile floor with reinforcement as shown and 1:3 Portland cement grout between the longitudinal courses; second, the same arch-tile floor covered with 1:2:6 cinder concrete 4 in. thick and a 1-in. timber flooring, and third, the cinder-concrete floor of the second test replaced by a 1:2:4 mixture of stone concrete 3½ in. thick with a ½-in. mortar wearing surface laid on top of the tile. The tile floor of the first test weighed 38.4 lb. per square foot, and the center deflection under this load was nearly ¼ in. when the forms were removed four days after construction.

The tests were made by loading the total floor surface uniformly, using piles of terra cotta or of pig iron and preventing arch action. Increments of approximately 25 lb. per square foot were used, and deflectometer readings of deflections at three points each across the center and both ends were made after each increase in load. For the first test the center panel was loaded, followed by the end panels for one increment, and the next increment was applied in reverse order; but for the other two tests the increments were always applied first on the center, then on the end panels.

RESULTS OF FLOOR TESTS

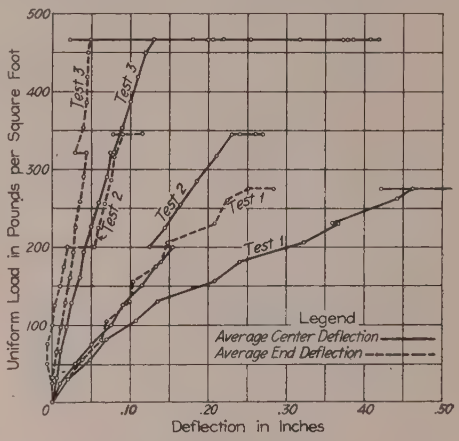
The accompanying diagram gives the deflections for each test at corresponding loads per square foot, and indicates the satisfactory values obtained. The center deflections were all less than that allowable for a span of 19 ft. It should be noted, however, that full continuity of action is obtained by loading the outside panels, and that no test was made with load on the inside panel only.

The greater stiffness of the thicker floors used for tests 2 and 3 is clearly shown by comparing the average center deflections at 100 lb. per square foot and 200 lb. per square foot in the table.

This table also indicates a constant load-deflection ratio of increase for tests 2 and 3, but not for test 1 on the tile floor.

Load, lb. per sq. ft.	Average deflections at center, inches		
	Test 1	Test 2	Test 3
100	0.10	0.07	0.02
200	0.30	0.14	0.04

At the maximum load in the third test the concrete cracked across the full width over the north 12-in. I-beam support, and later (that night) over the south support. The cantilevers afterward gradually settled down until they rested upon timber supports provided to prevent dropping of the ends, but the center panel did not deflect further under the maximum load of 465 lb. per square foot, which was allowed to remain for five days. When the load was removed the center of the floor returned to within 3/16 in. of its original position. No cracks or other evidences of excessive stress in either concrete or tile were found except over the supports.



DEFLECTION UNDER TEST LOADS

TESTS OF FLOOR SLABS

Three small floor slabs, 37 in. wide, were also built and tested as simple beams, with a span of 6 ft. 8 in., using a central load applied by a hydraulic ram. These slabs were built of the same tile construction as the floor panels, but with the openings longitudinal. The first slab contained no steel, the second ¼-in. and ⅜-in. square steel rods in the joints near the bottom (four rods of each kind), and the third like the second, but with the addition of 3¼ in. of stone concrete on top of the tile. As already mentioned, the first slab failed under the first load of from 800 to 1000 lb. The second slab failed under a central load of 15,000 lb. and the third at 25,000 lb., corresponding to 1455 and 2427 lb. per square foot equivalent uniform load in each case. The deflection-load diagrams for these two slabs appear practically straight up to at least one-half the ultimate load.

In conclusion, the report states that success in the continuous type of floor construction depends directly upon the provision for tensile and compressive stresses over the supports. The tieplates connecting top flanges of longitudinal I-beams should be of sufficient section to take the tensile stress, and shims or wedges should be used at the lower flanges to transmit the compressive stress.

STATE HIGHWAY BONDS TOTALING $475,000 were recently sold at a single allotment in Tulare County, California, when a local private firm bought in the entire issue at 4 per cent on a bid of 95⅛. These bonds are to mature in 1949, 1950 and 1951.

Multiple Flow Chambers in Imhoff Tanks

With More Than Two Settling Channels Danger of Cross Currents Through Sludge Chamber Must Be Avoided — Method of Dividing Flow Equally

By JOHN H. GREGORY
Consulting Engineer and Sanitary Expert, New York

IN the Engineering Record of Jan. 16, page 72, in an article on "Multiple Flowing-Through Chambers in Imhoff Tanks" it is stated that "rectangular tanks with several flowing-through chambers over a common sludge-digestion chamber have been suggested for Imhoff tank design . . ." and that such a tank having three flowing-through chambers had recently been constructed. The use of multiple flowing-through chambers has received much careful study for several years by some of the engineers who have been called on to design and construct sewage disposal works and perhaps a few comments on the subject may not be amiss.

The term multiple flowing-through chamber, as used in the article referred to, gives the reader the impression that there must be three or more flowing-through chambers over a common sludge digestion chamber. To the writer, however, it would seem that any tank having more than one flowing-through chamber over a common sludge digestion chamber would fall in the class of tanks having multiple flowing-through chambers, If, then, the writer's understanding of what is meant by tanks having multiple flowing-through chambers is correct, it may be stated that rectangular Imhoff tanks of the multiple flowing-through type with two flowing-through chambers over a common sludge digestion chamber have been in operation in the United States for several years, that others are now under construction, while still others have been and are being designed.

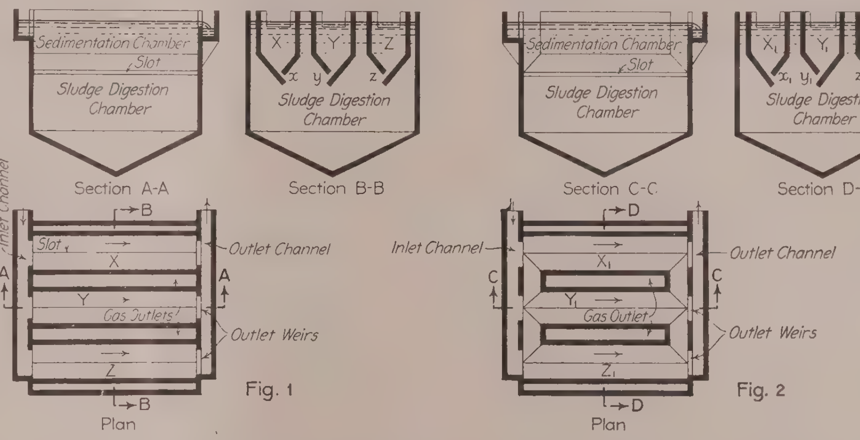
OPERATION SIMPLEST WITH LESS THAN THREE CHAMBERS

Tanks having more than two flowing-through chambers have possibly not been studied as much as those having only two flowing-through chambers but they have, nevertheless, received serious consideration. The writer had occasion in 1909 to study in detail the use of multiple flowing-through chambers over a common sludge digestion chamber as applied to rectangular tanks, shortly after he had returned from an extended trip to Europe where he had spent considerable time investigating the Imhoff and Hampton tanks, and others of somewhat similar design. He came to the conclusion then that multiple flowing-through chambers, under some conditions, would be found advantageous, especially in the remodelling of existing tanks, but that, under conditions ordinarily met with in American practice, rectangular tanks having not more than two flowing-through chambers over a common sludge digestion chamber would be found easier to design and simpler to construct and operate than tanks having more than two such chambers. From experience gained in the last 6 yr. he sees no reason to materially modify the conclusions then reached.

The article above referred to further states: "In multiple flowing-through tanks there would apparently be no greater tendency for sewage to pass from sedimentation chamber to sedimentation chamber through the common sludge digestion chamber than there would be for an interchange of contents to take place between a single flowing-through chamber and the sludge digestion chamber beneath it. Experience has demonstrated. . . . that such a tendency, if it exists at all, is very slight. Theoretically, of course, due to relative temperature changes, such an interchange of liquid might take place. Where several sedimentation chambers in a single unit are proposed great care must be taken to proportion accurately the flow of sewage between them by the use of suitable and sufficient inlet and outlet devices. Such devices, it is believed, can be readily arranged."

CROSS-CURRENTS THROUGH SLUDGE-DIGESTION CHAMBER

The reader might, perhaps, be led to believe from the above that, with multiple flowing-through chambers, there would be but little tendency for the sewage to pass from sedimentation chamber to sedimentation chamber through the common sludge digestion chamber, and that experience had demonstrated that if such a tendency did exist it would be very slight and would not require special consideration. The writer's experience is that in some tanks having multiple flowing-through chambers not only has the tendency existed but sewage has actually passed from one sedimentation chamber to another through the common sludge digestion chamber, a condition demonstrated not only by experiment, but by the unsatisfactory operation of the tank. If, then, it is possible for such a tendency to exist it certainly should receive the most careful consideration.



FIGS. 1 AND 2—ILLUSTRATING HOW WEIRS FAIL TO PROPORTION FLOW, AND MEANS OF REMEDYING TROUBLE BY NOT CARRYING GAS VENTS THROUGH TO THE OUTER WALLS

The writer has in mind several cases in which tanks had not been properly designed so as to prevent the flow from one sedimentation chamber to another through the common sludge-digestion chamber. It is, perhaps, hardly necessary to state that, for satisfactory operation, it is of the greatest importance to prevent the passage of sewage from one sedimentation chamber to another through the common sludge digestion chamber. In properly designed tanks having multiple flowing-through chambers the passage of sewage through the common sludge digestion chamber can practically be prevented or at least limited to a negligible minimum, but this feature of design has not always received the consideration that it should have.

PROPORTIONING THE FLOW

In the last quotation above referred to it was, however, pointed out that where several sedimentation chambers were to be used in a single unit great care must be taken to proportion accurately the flow of sewage between them by the use of suitable and sufficient inlet and outlet devices and that, it is believed, such devices can be readily arranged.

This point cannot be emphasized too strongly. If there is no connection between the sedimentation chambers except through the common sludge digestion chamber the use of weirs at either or both the inlet and outlet ends of the tank cannot be relied on to properly proportion the flow through the several sedimentation chambers. Orifices are better, but even if the proportion of flow obtained by them was perfect they would, under many conditions, cause too much loss of head, and they have other objectionable features, as for example failure to distribute the volume of flow as uniformly as possible over the cross-section of the sedimentation chamber at either or both ends.

The failure of weirs to properly proportion the flow through several sedimentation chambers constructed over a common sludge digestion chamber can best be illustrated by reference to Fig. 1. The sketch is not supposed to show an actual design but has been prepared merely for illustration. The sewage enters the three sedimentaton chambers *X*, *Y* and *Z* from the inlet channel and passes out over the outlet weirs into the outlet channel. Let it be assumed that the surface of the liquid in the three sedimenation chambers at the inlet end is exactly at the same elevation. If, now, the sedimentation chambers are identical in construction and the outlet weirs are exactly alike and set exactly at the same elevation then, theoretically, the flow through each of the three chambers should be the same.

As a matter of construction, however, it is exceedingly difficult, no matter how much care is taken, to get the outlet weirs exactly alike. If the weirs are not alike then a different volume will flow over each of them. Under such conditions what occurs? Let it be assumed for simplicity that the same volume flows over the outlet weirs in *X* and *Z* but that a greater volume flows over the outlet weir in *Y*. It is evident, then, that some sewage must flow from X and Z through the slots x and z into the sludge digestion chamber and thence through the slot y into Y. It is the continuous flow of sewage thus through the sludge digestion chamber which may cause trouble. It is, of course, conceivable, and under some conditions possible, that the flow may be so small as not to cause trouble, but a design in which such a flow is easily possible should, to say the least, be looked on with suspicion.

HOW TO DIVIDE FLOW EQUALLY

One simple method by which the flow through the three sedimentation chambers can be practically equally divided is shown in Fig. 2. The tank is identical in construction with that shown in Fig. 1 except that at both the inlet and outlet ends direct communication between the three sedimentation chambers has been provided by shortening the gas outlets and not carrying them through to the outer walls. Even if the flow through each of the three inlets is not identical the surface of the sewage at the inlet end of the three sedimentation chambers X_1, Y_1 and Z_1 will be at the same elevation, as the liquid would distribute itself so as to practically accomplish this result. A similar condition would exist at the outlet end. If, now, different volumes are flowing over the three outlet weirs the volume of sewage flowing through X_1, Y_1 and Z_1 would be substantially in direct proportion to the flow over the outlet weir at the end of each sedimentation chamber. The tendency for any flow of sewage through any one of the slots x_1, y_1 and z_1 into the sludge digestion chamber and out through either one or both of the others would be reduced to a minimum. Practically, the flow can be so reduced as to be a negligible quantity, if not entirely prevented. As a still further precaution it would be possible to make the cross-section of each of the sedimentation chambers bear the same ratio to the total cross-section as the flow through each of the sedimentation chambers bears to the total flow.

The writer has in mind two tanks in which openings had to be made between the sedimentation chambers in order to prevent the flow of sewage from one sedimentation chamber to another through the common sludge digestion chamber.

These comments have been written for the purpose of calling especial attention to the necessity of taking great care when designing Imhoff tanks having multiple flowing-through chambers over a common sludge digestion chamber. The writer has found it most helpful, after having made a design or had one submitted to him for consideration, to study it not only from the structural standpoint, but also from the viewpoint of the operator before passing final judgment.

Panama Canal in Miniature Operates at Exposition

Entire Zone Built to Scale in 200 x 565-Foot Amphitheater Where Boats and Trains Actually Pass from Panama to Colon

In an oval amphitheater 200 x 565 ft. in plan, the Panama Canal Zone has been reproduced in complete detail at the Panama-Pacific International Exposition, and visitors are being shown vessels actually passing through the locks in a tropical setting which is a true duplication of the topography and landscape of the isthmus. No operators are visible to the spectators, but vessels are continually traveling from ocean to ocean, being locked through the canal and hauled by the "electric mules," while miniature trains on the Panama Railroad operate between Colon and Panama, passing through tropical jungles depicting those of the Canal Zone. To reproduce the forests adequately it was considered worth while to make up by hand more than a million individual replicas of palms and other tropical growths. The reproduction is housed in a structure designed to harmonize with the other exposition buildings and covers an area of about 4 acres.

The topographical features of the zone and all artificial and natural waterways, together with the shore lines of the Pacific and Atlantic Oceans, have been reproduced from Government survey data furnished for this purpose by the Isthmian Canal Commission. The scale upon which the reproduction was designed is about 1 to 600 horizontal, with a vertical exaggeration of 4 to 1, this latter being necessary in order to feature the topography and canal locks. The entire reproduction is depressed so that the ocean levels are about 20 ft. below the spectators in order that the zone may be viewed in its entirety. On the walls that border the amphitheater there is carried out a panoramic perspective which lends the general effect of a boundless horizon miles in extent.

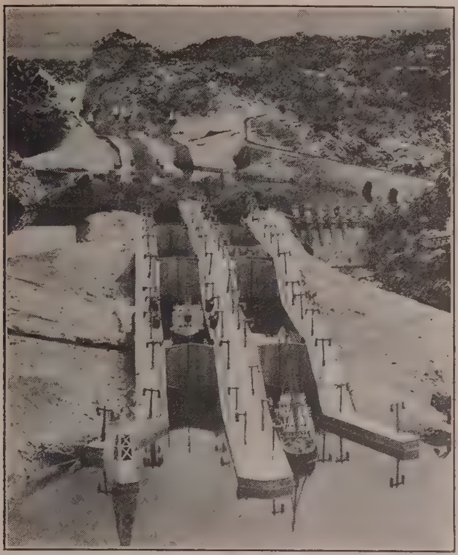
MOVING PLATFORM FOR AUDIENCE

Encircling the oval is a promenade bordered on the inner edge by a moving platform 1146 ft. in length, with a seating capacity of 6000. This platform moves continuously around the reproduction at a speed of 47 ft. per minute, making the entire circuit in 24 minutes. Electric motors are used for operating the platform by means of a rack-and-pinion drive arranged beneath the floor. The platform is divided into 8-ft. sections so it can move freely on curves, and each section is inclosed by a 2-in. pipe railing after the fashion of theater box seats. A telephone receiver provided for each chair delivers a lecture on the objects which are successively passed as the platform moves around the circuit. By this means each person receives his own independent lecture as he travels by the various objects of interest. The relay telephone system employed was specially designed for this purpose in the laboratory of Thomas A. Edison.

MECHANICAL DETAILS

Along the entire length of the channel from ocean to ocean are the range towers, buoys and all navigation signals of the canal, correct as to location and lighting

RADIO TOWERS 600 FT. HIGH STAND AT A PROMINENT POINT ALONGSIDE THE GATUN LAKE CHANNEL



MIRAFLORES AND PEDRO MIGUEL LOCKS

Note Culebra Cut in background

arrangement, and the vessels which pass through the locks will move at the same relative speed as the originals. The vessels will be drawn through the oceans and Gatun Lake by the attraction of large magnets operated on tracks underneath the floor, but will be actually towed through the locks by miniature "electric mules," which, in turn, are operated by underground cables. The moving magnets are drawn along their tracks by steel cables, and are energized by current transmitted through the rails on which they operate. The vessels carry iron cores which are about 2½ in. above the cores of the magnets, and the influence is exerted through a gap of air, wood, tar, cement and water. When a boat reaches a lock it is released from the influence of the moving magnet by means of downward deflection in the track, and a stationary magnet, located below the floor at this point, connects the vessel with a miniature cable from one of the "electric mules."

MAGNETS TRAVELING ON CABLE SYSTEM

There are three ¼-in. endless-cable systems beneath the floor. The longest of these, 535 ft. in length, is on the Atlantic side and is driven by two 1-hp, 110-volt synchronized motors, geared to a 3-ft. sheave around which the cable passes. The other cable systems are 450 and 375 ft. long respectively, each being driven by a 1-hp motor.

In designing cable systems of this length two of the problems that required special attention were to keep the friction as low as possible and to evade the difficulties resulting from the twisting of the cables. That this has been done satisfactorily is demonstrated by the fact that the system is operated successfully by the light equipment mentioned. There are a large number of curves in the system, the sharpest of which have radii of 18 in., and at these points self-oiling idlers with vertical shafts are provided, spaced 6 in. apart. The connection between cable and magnet truck is effected by a clamp carrying a German silver band, within which the cable is free to revolve as it will, and which has a spring coupling at the truck to allow for play at switches or curves. In order to take up any slack that might occur in the cable, the platforms carrying the motor drive are on wheels and are counterbalanced by a 100-lb. weight on each cable system.

The Panama Railroad system is laid out in its entirety with track of ⅝-in. gage. Replicas of the locomotives and cars are constructed of brass and are built for actual service, even to the extent of putting springs in the trucks. The locomotives are 5 in. in length and are equipped with an electrically heated flash boiler into which water from the tender can be injected by operating a magnet located in the cab. Steam thus produced jets periodically from the whistle.

The steam as well as the smoke produced by a chemical placed in the forward part of the boiler, is, of course, only to complete the representation. Motive power for each train is furnished by a miniature motor located in one of the box cars. This motor takes current from one of the rails and the circuit is grounded through the other rail. Thus, one of the rails is always grounded while the other is maintained at a potential of 18 volts. This system necessitated intricate switch connections because part of the line is single track, and thus one rail must sometimes be positive and sometimes negative, according to the direction in which the passing train may chance to be traveling.

CONTROL OF BOATS AND TRAINS

The movements of boats and trains are controlled by operators beneath the floor of the reproduction, who manipulate levers and switches in response to electric signals from observers stationed in two lookout towers that command a bird's-eye view of the amphitheater. The water levels in the various parts of the system are regulated automatically. Two electrically driven pumps, which are put in operation if the water level raises ¼ in., discharge into a storage tank on the roof, from which water flows to any part of the system where the level is sinking. The locks are constructed to be as nearly leak-tight as possible, but a ⅝-in. auxiliary piping system and a hidden overflow are provided to insure maintaining the desired level, independent of the normal operation.

L. E. Myers, of Chicago, conceived the idea of the reproduction described in the foregoing, and the construction has been carried out under the personal supervision of T. S. Johnston, M. Am. Soc. C. E., chief engineer for the L. E. Myers Company.

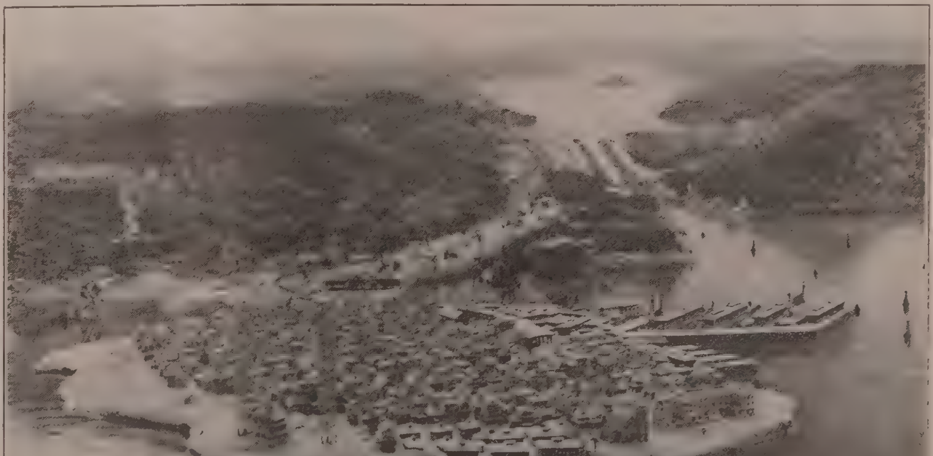
Failure to Act on Application for Extension of Time

By WILLIAM B. KING
Of King & King, Washington, D. C., Members of the Bar of the Court of Claims

THAT failure of the Government to act on an application of a contractor for an extension of time on the contract is equivalent to granting the extension was established by a recent decision of the U. S. Court of Claims. In the case of the receivers of the Noel Construction Company the specifications contained two paragraphs evidently clipped from some forms elsewhere in use, one providing for liquidated damages for delay and the other providing for payment of actual expenses caused by delays. An extension of time was authorized to be granted by the Navy Department for various causes specified, and the contractor during the progress of the work applied for such extension. No final action was ever taken upon the applications, and the court treated the failure to act upon them as equivalent to an extension for a reasonable time. It was held that the contract was completed in a reasonable time and that the Government had improperly withheld the liquidated damages stipulated in the contract. The actual expenses, amounting to a very small sum, were allowed against the claimant.

This contract also provided for a final release preceding the final payment. The contractor objected to executing this release and the Secretary of the Navy wrote that the release might be accompanied by any statement explaining the contractor's attitude. The contractor thereupon notified the Secretary of the Navy that he did not intend to release the claim for payment of liquidated damages withheld by the Secretary of the Navy. The court held that the release and this communication must be read together and that the letter qualified the release.

MILWAUKEE'S TYPHOID RATES PER 100,000, 11 in 1913 and 8.25 in 1914, are the lowest experienced in thirty-nine years. The water was treated intermittently from 1910 up to the beginning of 1913. Since then all water pumped has been treated regularly under the direct supervision of the city chemist at rates of from 0.13 to 0.37 parts per million of available chlorine.



CITY OF COLON, WITH GATUN LOCKS AND LAKE IN BACKGROUND

Literature

For the Civil Engineer and Contractor

New Publications

United States Coast and Geodetic Survey—Description of Its Work, Methods and Organization. Special Publication 23, Department of Commerce. Paper, 6 x 9 in.; 56 pages; illustrated. Washington, D. C. U. S. Coast and Geodetic Survey.

Presents a concise statement relating to the origin of the Survey, to the general plan of its operations, to the methods and processes whereby the work is carried on, and to some of the more important results reached in its progress.

Civil Engineering Types and Devices. By T. W. Barber, M. Inst. C. E. Cloth, 6 x 9 in.; 245 pages; 1760 illustrations. New York, D. Appleton & Company.

A classified and illustrated index of plant, construction, machines, materials, means and methods adopted and in use in civil engineering works of every class for the use of civil engineers, draftsmen, students, builders and contractors. The book consists entirely of simple outline sketches illustrating short definitions or descriptions of the engineering data above mentioned and contains no details whatever concerning design or construction.

Industrial Health Hazards and Occupational Diseases in Ohio. By E. R. Hayhurst, A. M., M. D., director, Division of Occupational Diseases, Ohio State Board of Health. Paper, 6 x 8½ in.; 438 pages; illustrated. Columbus, Ohio. E. F. McCampbell, Secretary, Ohio State Board of Health.

An investigation of the effect of occupations upon the health of those engaged therein, with special reference to health-hazardous conditions, as reported by a special staff of investigators who inspected about one-half of those employed in manufacturing industries and in some non-manufacturing industries in the State of Ohio.

Modern British Permanent Way. By Cecil J. Allen. Cloth, 8 x 10 in.; 147 pages; illustrated. London, The Boswell Printing & Publishing Company, Ltd. 6 shillings net.

Originally written as a series of articles for the "Railway News," in which they appeared at various periods between 1911 and 1914. Of interest to American railroad men chiefly as showing the great differences between American and British practice.

Books Reviewed

The Panama Canal

Authors, Reuben E. Bakenhus, of the Corps of Civil Engineers, U. S. N.; Capt. Harry S. Knapp, U. S. N.; Emory R. Johnson, professor of transportation and economics, University of Pennsylvania. Cloth, 6 x 9 in., 257 pages, 20 illustrations, 6 folding maps and plans. New York, John Wiley & Sons, Inc. $2.50.

This volume is not an engineering treatise, although it covers some matters of an engineering character on which engineers should be informed. The first part of the book, descriptive of the design and construction of the canal, is not of a technical character. It presents the main features in a very readable manner. The second part discusses the navy and the canal and the canal in international law. The last part treats of the canal's commercial importance. The second and third parts will probably be of the greater interest to engineers, the subject matter of the first part having, from the engineering standpoint, been more satisfactorily covered in the technical magazines. Messrs. Bakenhus, Knapp and Johnson treat the first, second and third parts respectively.

Captain Knapp's discussion of the effect of the canal on naval strength and organization is most interesting, while Professor Johnson's presentation of the commercial importance of the canal, though brief, gives the fundamental information on this, the second of the two great reasons—military and commercial—for the construction of the waterway. The book will give the engineer the information he should have on the purpose of the canal, while the first part will serve for ready reference to the general character of the structure when intimate engineering details are not needed.

The book, however, deserves a reading far beyond the engineering profession. It may well form a manual on the canal for the public at large.

Practical Irrigation and Pumping

Author, Burton P. Fleming, M.E., head of Department of Mechanical Engineering, State University of Iowa. Cloth, 5½ x 8 in.; 226 pages; 62 illustrations. New York, John Wiley & Sons, Inc., $2 net.

Reviewed by F. W. Hanna

Consulting Engineer, U. S. Reclamation Service, Ankeny, Iowa.

Owing to the existence of considerable literature on irrigation dealing mainly with problems relating to gravity irrigation systems and to the lack of the same fullness of treatment of the pumping side of the question, the appearance of a book on the subject of "Practical Irrigation and Pumping" will be welcomed by readers of irrigation literature. This is especially true at this time because of the narrowing of the field of economical gravity possibilities and the simultaneous impetus given to the development of pumping projects.

The author confines his discussion mainly to the subject of pumping water for irrigation, although his book bears the title of a broader subject. The first chapter discusses the amount of water required for the growth of crops and the remaining fourteen chapters deal with pumping plants and closely related problems. Although a little rearrangement of the chapters might result in a better sequence of the subject matter as a whole, each chapter is well written and abounds in good material.

The book is essentially of interest to those considering the installation of small pumping plants from the viewpoint of design, manufacture or operation, but is well worth reading by anyone interested in the general subject of irrigation. The flow of underground water as related to yield of wells is both simply and instructively presented and the same may be said of the discussion of centrifugal pumps. In the "Introductory Note" and again in the chapter on "The Question of Cost and Profit," the author offers some very commendable suggestions on the necessity of careful study of the feasibility of pumping projects, costs of pumping irrigation water and anticipated irrigation when considering the desirability of installing an irrigation pumping plant. These suggestions should be sufficient to cause an over-enthusiastic pumping-plant irrigationist to think before acting, but possibly a less optimistic estimate of crop returns would make him think twice before acting and would, therefore, be still better.

The book is rather elementary in treatment of the subject, but the author has not hesitated to use some mathematical analyses where they would be especially useful. Enough detailed description is given in the general discussions of the specific plants considered to make the book appreciated by the reader who is not technically trained. On the whole the work is a worthy contribution to irrigation literature and should be read by both irrigation engineers and practical irrigators who are considering the installation of small pumping plants or who have such plants under operation.

Regulation of Rivers

Author, J. L. Van Ornum, professor of civil engineering, Washington University. Cloth, 6 x 9 in., 393 pages, 99 illustrations. New York, McGraw-Hill Book Company, $4 net.

The author has divided his subject into ten chapters: Commercial considerations; general phenomena; investigations, surveys, etc.; methods of river improvement; principles of regulation; works of channel contraction; protection of erodible banks; dredging; levees, and control of current. The treatment of each is unusually complete and examples have been collected from all parts of the world. Naturally, the rivers of North America and the methods used by the U. S. Corps of Engineers are covered in more detail than are foreign streams and methods.

In the first chapter the author discusses European laws, which in order to favor the development of inland waterways prohibit the railways from reducing their rates below a figure about one-fifth greater than the water rate. A comparison is made between the ton-mile rates on railways in France and Germany on one hand and in the United States on the other, and of their relation to the capitalized cost per mile of road.

The second chapter emphasizes the necessity of a "keen appreciation of the natural condition of rivers and the laws of stream flow, as the successful improvement of a river is fundamentally dependent upon a thorough understanding of all these phenomena." The influence of various factors on the relation of rainfall to run-off is explained in detail. The chapter dealing with investigations and surveys explains the methods used in the United States and the costs of such work. Many references have been made to the annual reports of the Chief of Engineers, U. S. A. The last subdivision of the chapter deals with the qualification of riparian rights on navigable streams by the Federal Government's right to provide for navigation.

The remaining chapters treat in detail the engineering problems of river improvement. The treatment of each subdivision is extensive and the illustrations show well the points the author wishes to emphasize. The fact that a comparatively few engineers have in the past been concerned with river regulation will insure for the book a wider audience than would under ordinary circumstances be expected, especially since texts on the subject are lacking. Various methods of river improvement are described briefly, while the chapter on principles of regulation takes up the hydraulics of channels and the influence of contractions, curvature, etc. Channel contraction is then gone into in detail, with liberal illustrations of various methods and examples drawn from practice. Bank protection is the next division, and groynes, training walls, bank heads, open dikes, mattresses and various types of revetment are taken up. Dredging is discussed in 36 pages, giving attention to the grapple, dipper and elevator types of machine, hydraulic dredges and rock breakers. There is some general discussion of dredging costs. Levees are given 42 pages, the experience cited being principally that of the Mississippi valley. Under "Control of the Current" there is especial emphasis on the danger of too great reliance on theoretical considerations.

All in all, the book forms a valuable manual on the subject—one that fills a need in American technical literature.

Carrying Out the City Plan

Author, Flavel Shurtleff, of the Boston Bar, in collaboration with Frederick Low Olmsted, landscape architect. Cloth 5x8 in.; 350 pages. New York Survey Associates.

Mr. Olmsted in the introduction gives as the reasons for the preparation of the book the astonishing variation in the character and efficiency of the methods by which land is acquired for public purposes in the United States, and the variation in the distribution of the cost of improvements and in similar proceedings involved in the development of modern cities. The term city planning is used in the book not in the narrow sense to denote the development of a civic center or the building of a park, but to cover all the public development work both ordinary and extraordinary. Some of the laws are of a character to assist such development—to make it easy of execution—while others are a bar to progress. The purpose of the book is to differentiate between these, to present the advantages of the one class and the shortcomings of the other.

The first chapter, on the public ownership of land, takes up the rights of municipalities to own land and the limitations of that right. The second chapter treats of the machinery for land acquisition—through condemnation proceedings. The methods of various cities are presented in detail. Chapter three discusses the distribution of the cost of land acquirement, and gives details of the special assessment practices of various communities. Excess condemnation is covered in chapter four, and the use of police power, for such purposes as the limitation of height and size of buildings, and the control by zones of the character of occupancy. The final of the argumentative and expository chapters covers the work of the administrative agencies in the execution of a city plan. Under this are treated control boards, having jurisdiction over streets and buildings, and also the more modern development—the city planning commission. The final 140 pages are devoted to appendices, presenting extracts from laws, charters and ordinances governing the procedure discussed in the book.

The usefulness of the book to those engaged in the actual carrying out of the city plan, or who are advocates of intelligent planning and procedure, is obvious from the brief summary given. In fact, it is difficult to see how any one directly concerned with the execution of civic plans can do without the book. He may, it is true, be thoroughly familiar with the laws under which he is operating, but a knowledge of how others have solved the difficult questions which have arisen will in most cases be very helpful in solving local troubles.

EFFICIENCY TESTS and observations to the number of 3,861,962 were made by the Pennsylvania Railroad last year.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Another Mountainside Road

SIR: In your issue of Feb. 13, page 192, you present a picture of the automobile road on Storm King Mountain, Hudson River. I am sending you a photograph of a picture that I believe is more interesting to look at and more expensive to produce. It shows the Chattanooga Traction Company's line and automobile road immediately under Signal Point, on Walden's Ridge. The road is 1500 ft. above the river, shows Lookout Mountain in the background, but does not give you a view of Chattanooga.

FLANKED BY A 180-FOOT ROCK BLUFF THIS TENNESSEE ROAD EXTENDS ALONG A MOUNTAIN SIDE, 1200 FEET ABOVE THE RIVER

The road was built to develop Walden Ridge plateau, a beautiful mountain of the Cumberland Range. The Chattanooga Estates Company, owning 15,000 acres of this land, was instrumental in building the road, and they own the magnificent hotel and cottages on top of the mountain.

C. W. HOWARD,
Chattanooga Industrial Board.
Chattanooga, Tenn.

Opinions Wanted as to Desirable Factors of Safety for Dams

SIR: For use in a book on the design of dams, I am trying to reach as many engineers as possible for an expression of opinion as to the proper safety factors to allow in the design of masonry dams for overturning and for sliding as based on frictional resistance alone. I realize, of course, that such a statement might be much qualified, but there certainly could be such a minimum value under perfect conditions for remote or unimportant structures and a conservative value for important structures, or those the failure of which would be a catastrophe.

If not inconsistent, will you publish this letter in the hope that replies may be elicited from others than those directly reached by the writer?

C. A. MEES,
Designing Engineer, Southern Power Company.
Charlotte, N. C.

Concrete Tanks for Boiling Water

SIR: The writer would like to know what has been the experience of your readers in using concrete tanks for holding boiling water, the water being heated by steam.

G. D. WILSON.
Buffalo.

Top Thrust Bearings on Turbine-Driven Generators

SIR: Referring to the article in your issue of March 20, page 365, on the single-runner turbine at the Pennsylvania Water & Power Company's plant at Holtwood, I note with particular interest the point made in the improvement of the location of the thrust bearings on these large generators.

In 1907 we had occasion to design a hyroelectric development plant and at that time the writer insisted upon the location of thrust bearings for the vertical type units over the generators, but the electric companies did not see the force of our arguments. Later, in a much smaller plant where we insisted upon it, they reluctantly so designed their generators to include the top or upper thrust bearing feature. Hence it is with a great deal of satisfaction that I note the adoption of our idea as to the proper location of the thrust bearing in such large units as that mentioned in your article.

J. E. GIBSON,
Principal Assistant Engineer, American Pipe and Construction Company.
Philadelphia.

Economy of Bottom-Dump Wagons for Snow Removal

SIR: The present spring weather may seem to make out of date any reference to your editorial on snow fighting in your issue of March 13, page 318, but the bit of a "knock" which you give to the use of bottom-dump wagons would indicate that you had given thought to only one of the items which enter into the cost of moving snow, namely, the item of dumping. The cost naturally falls under three heads—loading, hauling and dumping. Either of the first two items are of much more importance than the last, and, if the use of bottom dumpers will save from 10 to 20 per cent on each of those items, a slight delinquency on the third item might be allowed; but even that saving is not to be made unless, as in the case mentioned, the load in the tip cart is very much smaller. Of course a one-horse cartload may be expected to dump much quicker than a two-horse load containing at least three times the material of the one-horse load. A wheelbarrow would dump still more quickly.

You have also omitted to note the fact that it costs considerable exertion to dump the tip cart, whereas the bottom-dump wagon uses the cheapest power in the known universe, namely, the force of gravity.

R. C. TILLINGHAST,
Watson Wagon Company.
New York City.

Work of Engineering Libraries

SIR: I note with great interest your editorial on the work of engineering libraries in your issue of March 20, page 351. First of all, the more the technical magazines open up the library field to the men in the technical world the more efficient will both the library and the technical journals become.

While for some time to come, and perhaps for all time, engineers will reap their greatest benefits from strictly engineering libraries, yet withal the technical departments of the larger public libraries will play their part in aiding the engineer. Such, of course, is being done in Pittsburgh, the District of Columbia, New York, Brooklyn, Seattle, Cleveland, New Haven and elsewhere. I believe that the engineering societies now at work on this subject would do well to get in touch with the American Library Association, and as I hope to place a motion before that society for the organization of a department of technical departmental librarians at their next conference to be held at Berkeley, backed by Edward Francis Stevens of Pratt Institute (at least, I have reason to believe that such a move would be backed by him), and possibly by Mr. McClellan, of the Carnegie Library, Pittsburgh, there should arise, if this vote is carried, a good working tool for the cooperation you have suggested.

I shall not take the time to discuss the many uses that we technical departments could be put to in the everyday use of books, but rather leave it for the future when scattered ideas can be drawn up into one huge idea. After my insight into the actual operation of such departments as that maintained at Pratt, New York Public and the department here, I feel sure we have much to offer. I sincerely hope that this move will receive the earnest support of every engineer, and it goes without saying that we librarians will lend every aid we can to the progress of a fine movement like that outlined in the Engineering Record.

KENNETH C. WALKER,
Head of Department of Technology, New Haven Free Public Library.
New Haven, Conn.

Would Give Construction Superintendent Salary and Percentage

SIR: For the past 10 yr. I have been employed on construction work, including railroad and highway work, laying pipe lines, structural steel erection, and dam construction. For the greater part of this time I have done the clerical work of keeping payrolls and cost records. These records were always figured out after the money had been spent, instead of while the work was going on as advocated in the article by Allen C. Haskell, which appeared in the March 13 issue of the Engineering Record. In my opinion, if the superintendents in charge of the work I have been on had had more than a mere salaried interest in the work, the cost of any piece of construction with which I have been connected during these 10 yr. would have been cut at least 10 per cent.

There was a time in the contracting business when foremen who would work their heads off as a matter of loyalty to the contractor were plentiful. Now this is a thing of the past, much as some companies seem not to see it. I think this is partly due to the size of some contracting companies, which makes it impossible for the man in charge of the work to come in personal contact with the heads of the company. Such superintendents do all their business with the main office by mail, telegraph and telephone, with only an occasional visit from a general superintendent.

I have seen in the Engineering Record during the past year or two several articles deploring the inadequate pay of engineers. In my humble estimation the engineer or superintendent in charge of work should have an agreement with the company that employs him for some compensation in addition to a fixed salary. He should have a statement of what the job is estimated to cost, and should receive, in addition to his salary, a percentage on any amount that he can cut this estimated cost. I am sure this would result in cheapening the work of any construction company.

A man working for a straight salary today, which has usually been fixed upon the basis of how little he will accept and not upon how much he can make for his employers, lacks the incentive necessary to get work done at the lowest figure by calling into play all his ingenuity. Under the arrangement outlined above this incentive will be introduced, and good results will follow. Various applications of this principle would have to be made to fit different classes of work, but this matter should be easy of adjustment for any large company. Charts and records of all kinds may be kept, but the man who "brings home the bacon" is the fellow with the good ideas. These ideas will surely come to the top under the stimulus of more money, given not as a salary, but as an appreciation for results accomplished.

PAUL MAHON.
Ben Avon, Pa.

Eleven-Span Wooden Arch Bridge of Fifty Years Ago

SIR: My attention was called to an article which appeared in the Engineering Record of Jan. 30, 1915, entitled "Eleven-Span Wooden Arch Bridge of Fifty Years Ago," referring to a military bridge constructed across the Tennessee River in Chattanooga in 1863 (not 1864, as stated in the article). In the article the writer indulges in some inferential criticisms on the judgment displayed by Gen. Montgomery C. Meigs, then quartermaster-general, by whom it was constructed, saying that "it was built of green timber cut and sawed from a hill near by, at the enormous cost of $750,000," and, "it was spoken of as 'Meigs' Folly,' after its builder."

Capt. S. Emlen Meigs, of Philadelphia, a brother of M. C. Meigs, upon the article being referred to him, furnishes the following facts:

The Union army, which had recently been defeated under General Rosecranz, and was then under command of General Thomas, was besieged in Chattanooga with its supplies cut off by the enemy under General Bragg. In one of General Bragg's reports to President Davis at this juncture, he said that "the present disposition of our forces faithfully sustained insures the enemy's speedy evacuation of Chattanooga for want of food and forage. We hold him at our mercy, and his destruction is only a question of time."

General Grant, who had also been ordered there, says in his "Personal Memoirs," Vol. 2, Chapter 41, that on Oct. 24, 1863, he, with many of his personal staff, and a few others, started to make an inspection of the situation. It was realized to be of great importance to re-establish communication with Bridgeport, a base of supply some 20 mi. off on the Tennessee River, inasmuch as the army was suffering from want of supplies, and many horses and mules were starving to death. He decided that this could be done only by building a bridge at Chattanooga *as soon as possible*.

Under General Grant's orders, General Meigs started the construction of the bridge referred to in the above article and pushed it night and day, with as many men as could be worked on it. It was built in five days, and the army, which afterward became Sherman's in his march through Georgia, was saved. It appears, therefore, that the bridge was an urgent military necessity, so urgent that without it the army in Chattanooga was in grave danger of starvation and capture.

General Meigs's offenses, so heinous in the opinion of the writer of the article referred to, of constructing the bridge, in the first place, of "green timber"; in the second place, at the alleged enormous cost of $750,000; and in the third place, in such a manner that an unusual rise of the river some years later carried it away, need no palliation in the minds of reasonable engineers. I do not know what authority the writer had for stating the cost of the structure as $750,000. Judging from the balance of his text, there is grave doubt as to the accuracy of this. This, however, is not important. The structure served its purpose well; it lasted as long as was necessary, and if it had been built of straw instead of "green timber," at double the alleged cost, and had lasted not an hour longer than was needed to get the army over it, it would have been justified by the emergency then existing.

Our critic, in his superior wisdom, presumably would have issued proposals for the construction of the bridge with properly seasoned timber and under rigid specifications. Doubtless the edifice thus built would have been a monument to his name, and equally doubtless, also, a monument to the name of Thomas and his army, which would have been immolated there.

The record of M. C. Meigs as quartermaster-general during the entire Civil War, and as one of the ablest engineer officers ever produced by the United States Army, needs no defense, but I wish to register this protest against such carelessly prepared and unfair pseudo-historical-scientific writings as that referred to above.

JOHN MEIGS,
Philadelphia. Civil Engineer.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

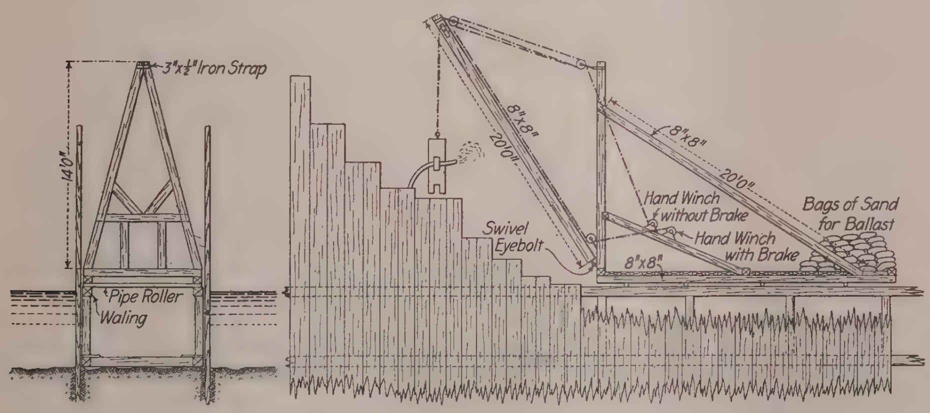
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Light Traveler Cheapens Sheeting of Trench Across River

By W. H. BROTHERTON
New York City

A LIGHT traveler, made on the job with less than $30 worth of timber, helped progress and lowered costs in driving the trench for the Farmington River crossing in the construction of the Nepaug pipe line at Hartford, Conn. The construction of this traveler, the irons for which were made in the job blacksmith shop, is indicated in the accompanying sketch. Two hand crabs, one provided with a brake, took the place of a hoisting engine, as rapid hoisting with this rig was not vital to the progress of the work.



LIGHT TRAVELER USED TO ADVANTAGE ON RIVER PIPE-LINE CROSSING

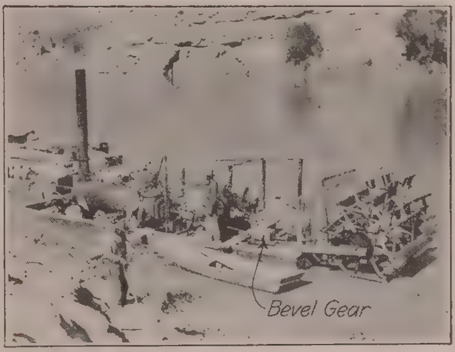
The trench, which was built across the river in three 100-ft. sections, was sheeted with 4 x 12-in. plank 16 ft. long. The average depth of water was 4 ft., which would have made easy the construction of staging for driving the sheeting by hand. The gravel bed of the river, however, made hand driving impossible, and a light steam hammer was used. Two sets of wales and bracing, with posts between, were first laid on the river bed, and the traveler rolled on top of them. After the sheeting was driven, the traveler assisted in the excavation by hoisting out of the trench a number of large boulders encountered. One man on the crabs and two to handle the steam hammer were required in driving the sheeting. When the traveler had to be rolled ahead, these men, helped by some of the excavating crew, readily moved it with bars.

The work was done by the Hanover Contracting Company, for whom the author was superintendent.

Diamond Drill Drives Boat

DIAMOND drill work does not always imply a knowledge of steamboat building, though at times it may lead to it. In this instance, a superintendent resorted to a Sullivan drill for motive power to get his crew and machinery out of a canyon on the Green River in Utah after a lengthy period of isolation.

The drill, which has a swivel head, was placed in the scow near the stern. The chuck, which clamps the drill rods to rotate them, was pointed toward the stern. Into this chuck, in place of a drill rod, was clamped a piece of shafting which drove a bevel gear enclosed in the small box indicated in the photograph. A chain running over two sprocket wheels connected this gear to the paddle wheel.



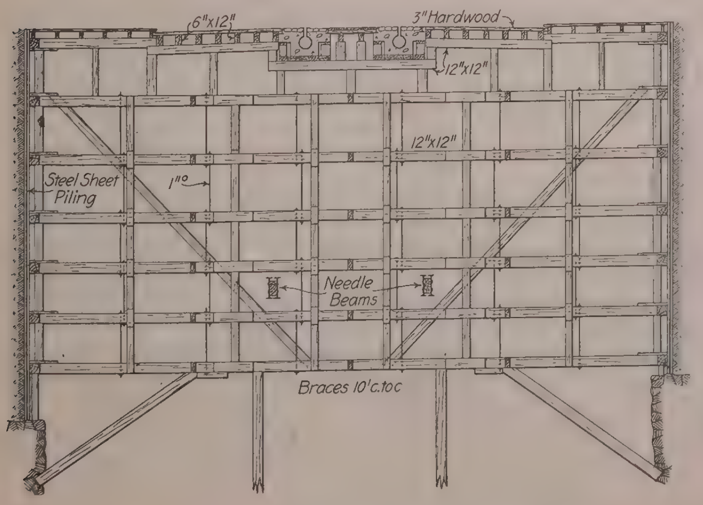
DIAMOND DRILL DRIVES STEAMBOAT

This "steamboat," with the little fleet shown in the photograph, bucked its way against a rather stiff current from the Colorado River to Green River, Utah. This journal is indebted to "Mine and Quarry," and to J. M. Heizer, who rigged the boat, for these notes.

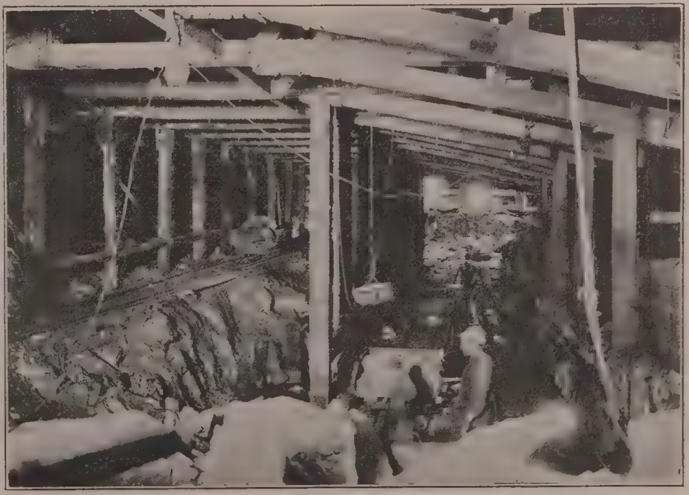
Heavy Timbering Trussed to Support Own Weight

TIMBERING under Lexington Avenue above 129th Street on the New York subway work now under way was trussed to help support its own weight and that of the car tracks and decking while rock excavation was in progress. This timbering is very heavy, having to resist large soil and water pressure above the rock.

The full depth of rock cut was taken out in one lift, where possible, as no bracing was required below the top of rock. A space of four lines of cross-bracing, or 40 ft., was supported at the working face by two needlebeams beneath the next to the bottom set of bracing. These beams, of course, were slipped forward 10 ft. at a time as the excavation progressed. The front end of each beam rested on rock behind the working face and the back end on



DIAGONAL TIES AND VERTICAL ROCK TRUSS BRACING



NEEDLE BEAMS CARRY TIMBER TRUSSES NOT POSTED one of the bottom cross timbers. This timber in turn, and all those behind it, were posted to the bottom of the cut with vertical and inclined timbers. Between the back end of the needlebeam and the face, however, there were no posts.

There was danger in blasting of a piece of rock knocking out the vertical and possibly the inclined post supporting the back end of the needlebeam. To prevent collapse of the street in case this occurred, all the bracing was trussed, as shown in the accompanying sketch. Diagonal ties of 3 x 12-in. plank were bolted to each vertical set of bracing. Vertical rods, one for each post, tied the horizontal timbers in each vertical set together. These rods were easily slipped through holes bored for them, after the bracing was in place, by springing them slightly. In addition, the ends of the vertical posts were scabbed together around each cross-timber, the scabs being bolted.

Of course, when a shot was to be fired, traffic was warned off the street above. Once or twice a vertical post under the back end of one of the needlebeams was actually shot out. In each case the trussed bracing supported the load till the post could be replaced.

This work is on the contract for section 14 of the Lexington Avenue subway, being constructed by the Arthur McMullen & Hoff Company, for whom N. R. Melvin is superintendent and G. A. Graham, chief engineer. For the Public Service Commission, C. V. V. Powers is engineer of the third division, and H. B. Gates section engineer.

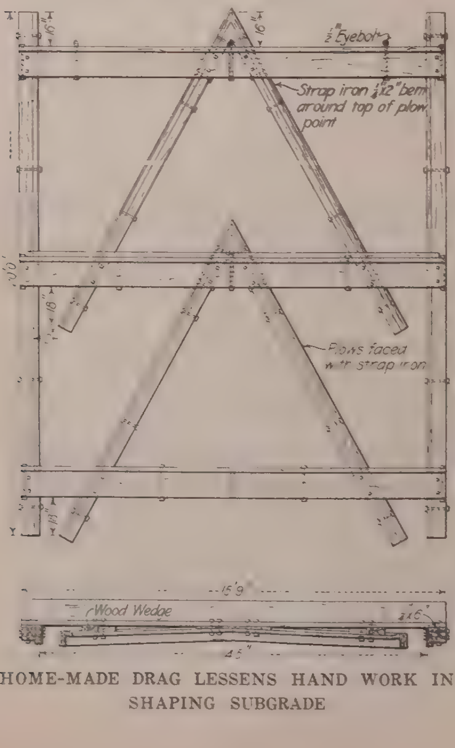
Home-Made Drag Shapes Subgrade Rapidly Without Hand Work

THE drag illustrated herewith has met with success in Western road work for shaping the subgrade for concrete on macadam pavements. Although designed for soft material, the drag has been used successfully on more or less rocky subgrades.

Headers, or rule-bars, are first set to grade on each side of the roadway. The subgrade is then thoroughly ploughed and scarified, and the larger clods broken. If sufficient material is left between the headers to be caught by the rear blade of the drag, the drag will fill all depressions without subsequent hand labor.

As the subgrade is dragged, the excess material slides along the bases of the blades, slips through the space between the ends of the blades and the runners, and is deposited along the headers. The excess dirt has to be shoveled off the roadway, but when this is done the subgrade is ready to be wet and rolled.

The bolts which fasten the blades to the frame are provided with wing nuts, so that the blades may be adjusted to any desired crown without using a wrench.


3/4" Eyebolt
Strap iron 1/2" bent around top of plow point
Plows faced with strap iron
8'0"
15'9"
Wood Wedge

HOME-MADE DRAG LESSENS HAND WORK IN SHAPING SUBGRADE

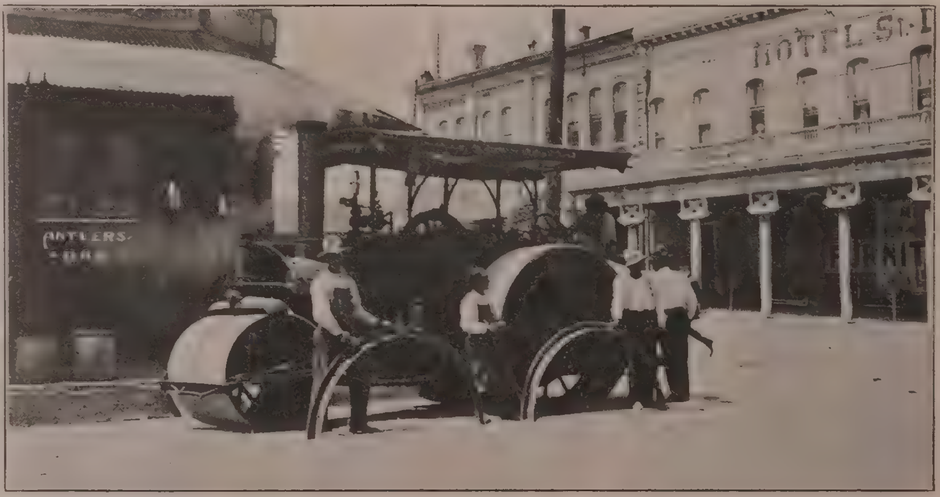
Angle-Iron Converts Steam Roller Into Pavement Cutter

By R. E. PALMER

Stone & Webster Engineering Corporation, Boston

ON a recent track job in Texas the Stone & Webster Engineering Corporation devised a means for removing pavement which saved more than half the estimated cost of the work and a considerable amount of time. The bitulithic surface to be removed was about 2000 ft. long and 8 ft. wide. The usual method of doing work of this kind is with broad axes, a slow and costly procedure requiring a large force of men.

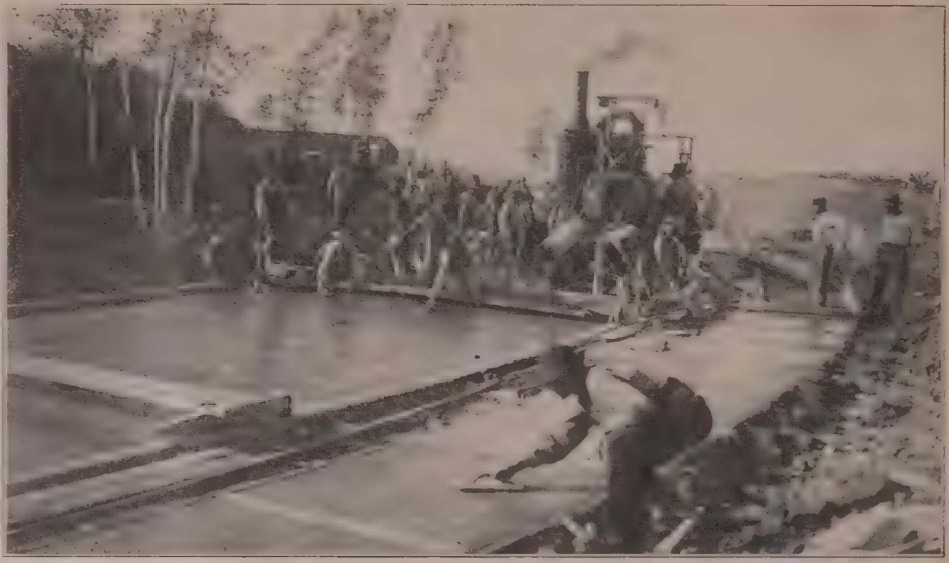
On the job in question two pieces of 3 x 3-in. angle iron were fitted to one of the wheels of a 10-ton steam roller, one side of the iron being sheared for a cutting edge. Two white lines, 8 ft. apart, were then painted on the pavement, to act as guides for the operation of the roller. As the cutter was placed on one wheel only the steering was not difficult and the weight of the roller drove the angle iron through the pavement. After two cuts had been made, each 2000 ft. in length, a gang of men rolled the pavement to one side. The device cost $10.



ANGLES BOLTED TO WHEELS OF ROAD ROLLER CUT OLD BITULITHIC PAVEMENT IN STRIPS EASILY ROLLED UP LATER BY HAND

Concrete Road and Sidewalk Laid Simultaneously Near Duluth

LAYING concrete streets and sidewalks simultaneously was a feature in the construction of the Minnesota Steel Company's new city near Duluth, known as Model City. All the streets are 22 ft. wide, with the exception of one, which has a parkway through the center and 18 ft. pavements on each side. The accompanying photograph strikingly brings out the method employed in laying the pavements. The mixer, standing in the foreground, has a 12-ft. delivery chute and was run on the grade without using planks.



LAYING PAVEMENT AND SIDEWALK SIMULTANEOUSLY CHEAPENS CONSTRUCTION ON DULUTH STREET IMPROVEMENT WORK

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Kansas City Still Unprepared for Spring Floods

As another flood season approaches, Kansas City finds no definite move has been made to levee the lowlands on which so much valuable property is located.

The East Bottoms protection levee proposed by S. Walters Fox failed of consummation because tax payers protested against providing a top width sufficient to carry a road, a width unnecessary for the dike it was contended.

The West Bottoms proposition involved negotiations with Kansas City, Kans., and the State of Kansas. The former would not listen to a necessary prolongation of the O. K. Creek sewer to the Kaw River across the state line unless the Missouri city would agree to treat the sewage at any time, on demand of the local laymen in Kansas. The larger city was willing to let the Kansas State Board of Health decide this technical question but agreement on this point could not be obtained, so improvements to the extent of $1,250,000 cannot go ahead. In addition to levees and fills this plan involved a long tunnel to divert Turkey Creek into the Kaw River, a dam to cause the diversion and an 1800-ft. extension of the O. K. Creek sewer.

The packers and some of the holders of the more valuable property will watch the weather reports carefully and if high water stages of menacing character are predicted it is likely a $20,000 embankment along the north bank of Turkey Creek will be constructed. This will save the major portion of the high-value district, but it is considered a temporary expedient only.

Syracuse Reduces Guarantee Period on Pavements to Five Years

The common council of Syracuse, N. Y., has passed an ordinance under which the guarantee period on pavements has been reduced from ten years to five.

Dr. Imhoff Trains Recruits on Holland Frontier

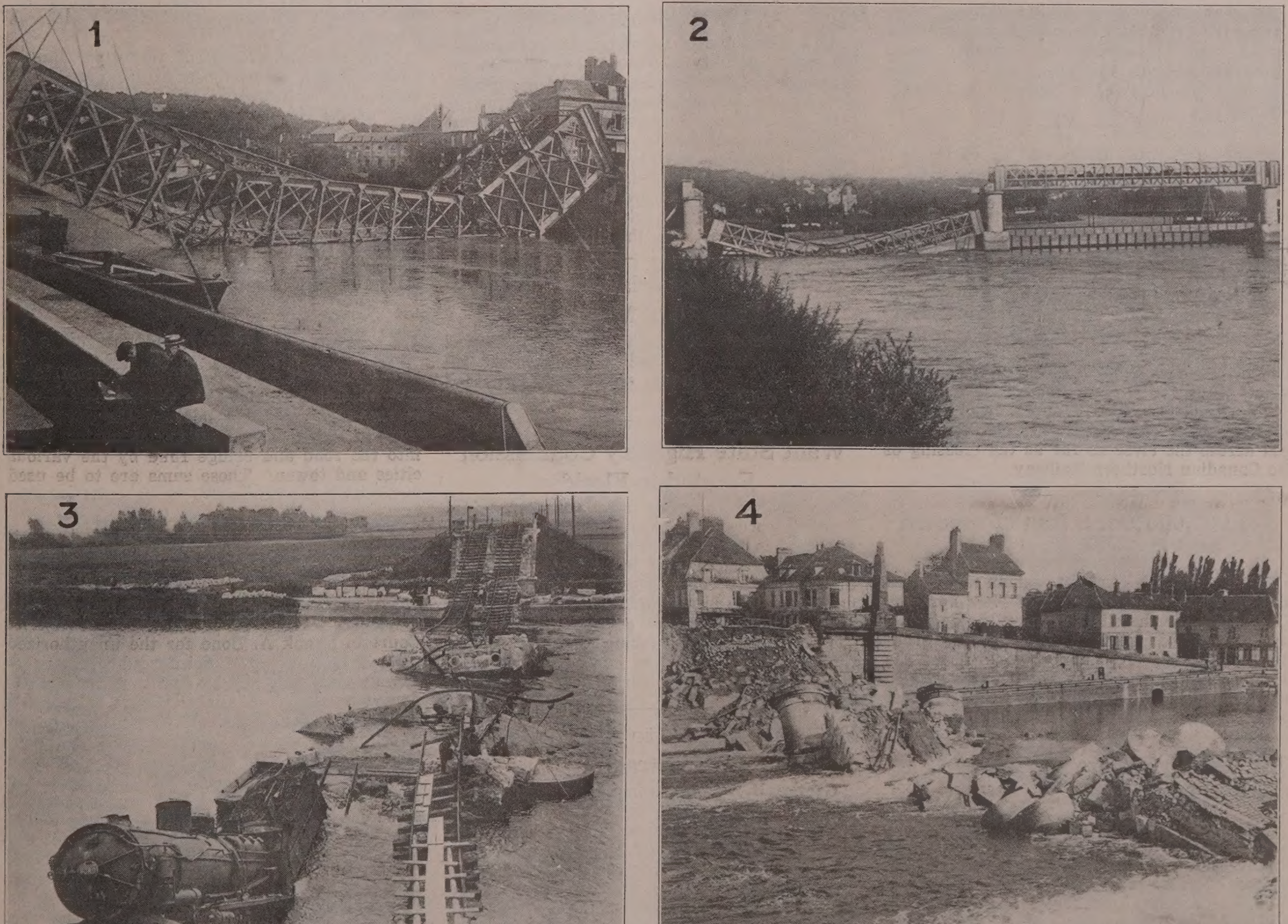
Dr. Karl Imhoff is still on the Holland frontier training recruits for the German army, according to a letter mailed Feb. 11 to Leslie C. Frank, of the U. S. Public Health Service, a former member of Dr. Imhoff's staff. The German medical authorities feared for Dr. Imhoff's health during the winter months and kept him out of the trenches.

Los Angeles Wins Aqueduct Water Suit After Lengthy Trial

At the end of forty court days, the suit brought to prevent Los Angeles from using aqueduct water was decided in favor of the city, and in handing down his decision, on Mar. 19, Superior Judge Lewis R. Works stated: "The conclusions reached in this opinion do not come from a mere preponderance of the evidence, but from an overwhelming weight of proof which leaves possible no other termination of the litigation. On the whole, the record in this trial furnishes a splendid indication of the judgment of the people of the city in acquiring and developing a water supply from the Owens River region. The application of the plaintiffs for an injunction is denied and the defendents will have judgment for their costs."

The question as to the length of time that water is stored in the Haiwee reservoir proved to be one of the important points on which the outcome of the case hinged. Mulholland testified that under present draft the water remained there 400 days and under full draft 38 days, All experts agreed that thirty days' storage was enough to purify it. In this connection Dr. E. O. Jordan of Chicago is re-

Part of the War's Heavy Toll on the Bridges of France



1. CREIL BRIDGE. 2. OPERATING BRIDGE AT ISLE-ADAM DAM ON THE OISE. 3. BRIDGE ACROSS THE OURQ, DESTROYED DURING THE BATTLE OF MEAUX. 4. THE PONT SAINTE MAXENCE.

ported to have said: "I should say that water delivered to the city of Los Angeles in the condition that the affluent from the Haiwee Reservoir is in, in my opinion, would be a safe, potable and wholesome water." Dr. Charles Gilman Hyde, engineer for the State Board of Health, also expressed as his opinion that the water was pure.

The opinion of Judge Works was somewhat brief. He mentioned the 150 maps and photographs that had been exhibited, the 1,250,000 words in the transcript, and gave a general outline of the entire proceedings.

Civil Engineers' Society Elects General Dodge Honorary Member

The American Society of Civil Engineers recently elected Gen. Grenville M. Dodge an honorary member. General Dodge was graduated from Norwich University, Vermont, in 1850 as a civil and military engineer and his first engagement along engineering lines was with the Illinois Central Railroad, in the capacity of assistant engineer. On various occasions previous to the Civil War he made explorations west of the Missouri River and in the Rocky Mountains for the purpose of determining upon the best route for a transcontinental railroad.

He became chief engineer of the Union Pacific in 1866 and held that office until 1871, during the location and construction of the road. From this date until 1874 he was chief engineer of the Texas & Pacific, and in 1880 was elected president of the Missouri, Kansas & Texas. From that date until 1892 his activities were almost entirely confined to the organization and management of railway lines and water carriers.

General Dodge attained his military rank during the Civil War. He made a distinguished record, and his engineering training manifested itself in the building of pontoon bridges and the rebuilding of the Nashville & Decatur Railroad.

Kettle Valley Railroad in British Columbia Nears Completion

Rail laying has been started with the advent of spring weather on the Kettle Valley Railroad in British Columbia, and it is expected that the last link in the connection with the main line of the Canadian Pacific Railway will be completed by June 1, in time for the inauguration of regular service when the new summer schedule becomes effective on the main line. The bridge over the Fraser River near Hope, which connects the main line of the Canadian Pacific Railroad with the new Hope Mountain line, has been completed and rails have been laid across the river as far as the crossing of the Canadian Northern Railway.

$25,000,000 Bond Issue Proposed for Grade Separation

A bill to submit to a referendum next fall a proposition to bond the State of New York for $25,000,000 for the elimination of grade crossings was introduced in the New York Legislature March 22. The money would cover the State's share of such work and the funds would be apportioned as elimination improvements were authorized.

Mr. Hazen Favors McGregor Lake for Ottawa Supply

In a recent letter to the city clerk of Ottawa Allen Hazen sets forth his views on the water supply situation in that city. Three possible sources of water supply are under consideration —unfiltered water from Thirty-one Mile Lake, unfiltered water from McGregor Lake and filtered water from the Ottawa River. In Mr. Hazen's judgment these three waters would all be of the same quality. No one could tell one from another except by careful chemical analysis. The McGregor Lake supply, Mr. Hazen believes, is the best for the city to adopt if the requisite rights can be secured on attractive terms. Otherwise mechanical filtration of the Ottawa River is preferred. The Thirty-one Mile Lake scheme is dismissed by Mr. Hazen on account of its excessive cost, $8,000,000.

Rail Production in 1914 Fell Off 44 Per Cent

Rail production in the United States in 1914 was 44 per cent less than in 1913, according to a bulletin issued by the American Iron and Steel Institute, and was less than in any previous year since 1897 with the exception of 1908. The total production was 1,945,095 gross tons, as compared with 3,502,780 in 1913 and 3,977,887 in the record year of 1906.

The production of open-hearth rail fell from 2,527,710 to 1,525,851 gross tons, while that of Bessemer rail dropped from 817,591 to 323,897 gross tons. In spite of the preponderance of open-hearth rail the figures show that 1911 was the first year in which the open-hearth output exceeded that of Bessemer. The great advance in the production of open-hearth rail was from 1906 to 1910, as in the former year all but 186,428 gross tons of the entire output was Bessemer rail.

Seventy-one per cent of the 1914 output was 85-lb. rail or heavier, as compared with less than 65 per cent in 1913. The falling off in the porduction of this heavy rail was 38 per cent. The production of rail under 50 lb. fell less than 12 per cent, while that between 50 and 85 lb. suffered a decrease of 68 per cent.

Detroit Engineers Endorse Proposed Plan Commission

As an example of a commendable engineering society activity of a local nature is the endorsement of the proposed city plan commission by the Detroit Engineering Society. A brief communication was sent to the Mayor and Common Council stating that the society had passed resolutions to this effect and the letter has appeared in the official city records. The commission would approve or disapprove designs for buildings, parks and highways or bridges to be erected in the city.

Waterworks Association Has More Than 1000 Members

The membership of the American Waterworks Association, according to the latest figures from J. M. Diven, secretary, has passed the 1000 mark.

Want State Highway Commission Created in Florida

The avowed purpose of the Florida Good Roads Association, as expressed at the convention held in St. Petersburg, Fla., March 24, is to seek the passage of legislation creating a State highway commission. Anticipating the passage of the bill, Prof. J. R. Benton, of the engineering department of the University of Florida, is said to be making an effort to have the headquarters of the engineering department located at the university.

Detroit Hesitates to Award Garbage Contract

George H. Fenkell, commissioner of Public Works, Detroit, has warned the Common Council that valuable time is being lost in the construction of the municipal garbage reduction plant due to the lack of action on the bids submitted Feb. 2. He protests at the delay and asks that the contracts be confirmed or rejected. In case of rejection he wants to know how to proceed to meet the emergency which will arise with the expiration of the Detroit Reduction Company's contract, June 30, 1916.

New York's Garbage Bill Vetoed by Governor

Governor Whitman this week vetoed Commissioner John T. Fetherston's bill to permit the city of New York to enter into a 15-year contract for the disposal of refuse. The provisions of the bill allowed the city to make a contract with a private corporation on a profit-sharing basis, substantially following the principles underlying the law governing the construction and operation of the subways. The city was to have furnished land and fixed structures if the contractor proposed to build the plant on city land; otherwise the contractor could furnish his own land, including fixed structures and equipment. On the termination of the 15-year contract period the land, plants, buildings and equipment would have reverted to the city.

Last year New York paid $1,400,000 for the disposal of its refuse. The new plant proposed in Commissioner Fetherston's bill was estimated to cost $9,000,000, and this investment, it was believed, would have returned a profit of 10 per cent. If a contract had been entered into, under the terms of the bill, the city would have invested $2,500,000 in fixed structures, and the contractor would have provided equipment costing $6,500,000. Under normal conditions the total investments in fixed structures would have been returned to the city in not more than 6 or 8 years.

Governor Whitman, however, expressed the opinion that in view of the city's present distended budget and the grievous burden of taxation, "it is certainly questionable whether the city should lend its credit or its funds to the erection and equipment of an enterprise in which private individuals, firms or corporations concededly will derive a substantial income at the expense of the city's legitimate income.

"The striking growth of the city's annual budget, which seems to defy all efforts at reduction or control, and the mounting aggregate of the city's debt, certainly impose upon every public official who is called upon to act with reference to this subject matter, the duty of a rigorous conservatism.

"For the reasons stated, I feel that no occasion has been affirmatively demonstrated for any enlargement of the very liberal powers conferred upon the Commissioner of Street Cleaning under Section 544 of the Greater New York Charter."

Bill Signed to Return Percentage of Taxes for Street Improvements

A bill has been signed in the State of Washington that makes mandatory the return to them of 15 per cent of the money paid in taxes into the road and bridge fund by the various cities and towns. These sums are to be used in street improvements.

Reinforced-Concrete Retaining Wall Infringement Decree Affirmed

The decree of infringement against the city of Akron, Ohio, granted by the U. S. District Court to Frank A. Bone for the unauthorized use of features of a reinforced-concrete retaining wall patented by him in 1899 was affirmed by the U. S. Circuit Court of Appeals March 2. "Bone's Patent" system consists of a comparatively thin vertical wall, broadening at the base into a heel and toe. The heel extends back for a considerable distance under the bank to be retained and, so long as the structure remains unitary, the assumption is that the weight of the bank resting on it operates to prevent the wall from tipping over. To prevent break in the wall by horizontal pressure, continuous vertical reinforcing is provided which extends up and down the wall and obliquely into the heel. In this particular case, the court decided that the infringement was perfectly clear in that the advertisement for bids called for a wall built by the "Bone Patent."

California Inland Waterways Association Holds Convention

The Inland Waterways Association of California held its convention at San Francisco, March 23, 24 and 25. The Sacramento River Flood control project was indorsed as of vital importance to California's welfare; the work of safeguarding the Sacramento and San Joaquin rivers was approved of and recommendations were made for its early completion; the plan of the California Débris Commission for reclaiming the central valley was indorsed and it was proposed that the State appropriate $500,000 in co-operation with the Federal Government to further the work; and the plan for State and National co-operation, and appropriation of money, to clean the silt brought down by the San Gabriel and Los Angeles rivers, from San Pedro and Long Beach harbors, was also approved of. It was further decided to petition Congress for an appropriation for impounding the water of the Colorado River; and, finally, it was voted not to commit the association in favor of any project until the project had been approved by its own engineering authority.

The association agreed to meet again in Fresno this year with the International Irrigation Congress, and also to meet and co-operate with the National Drainage Congress, which will convene in San Francisco next September. Of the seven bills pending in the State Legislature the only one unqualifiedly indorsed was that authorizing the appointment by the Governor of a conference board on flood control and reclamation consisting of at least a dozen State officials and experts.

At the final session of the congress, Isadore Jacobs, president of the California Canneries Company, was elected president for the ensuing year. M. E. Dittmar, of Redding, was named as first vice-president and executive officer of the association. The organization now has 833 members, the membership including 277 commercial organizations, 47 banks and 11 subscribing counties.

U. S. Board of Commerce to Study Unemployment Question

Actuated by the fact that plans are being made for a National system of labor exchanges to deal with the question of unemployment, the board of directors of the Chamber of Commerce of the United States, at its meeting in Washington, March 20, voted to appoint a committee to study these plans. The work of the committee will be to devise means by which business men may best co-operate with the Federal authorities in an effort to make these exchanges most effective.

Repairs Under Way to Breakwater at Panama Damaged by Storm

Work has been begun, states the "Canal Record," in driving a new trestle for the construction of the east breakwater in Limon Bay, Canal Zone, to replace the sections washed away Feb. 9. The plan of construction has not been materially changed. The approved project provides that the breakwater as completed shall be a detached mole, with its outer end 2000 ft. from the outer end of the west breakwater. Its length will be 5400 ft.

At the time of the storm that did the damage the approach trestle had been completed for its full length of about 5900 ft., 3700 ft. of the trestle for the breakwater had been built, fill from suction dredges had been placed most of the way, a pipe-line relay station had been built along the approach trestle, 1600 ft. from shore, and a second relay station was under construction at the outer end of the approach trestle. The 4200 ft. of approach trestle between relay stations was entirely swept away. Eonugh heavy material had been dumped around the breakwater trestle so that it held in part, although at some points nothing remained except the piles. The platform of the outer relay station held firm and became the refuge of the sixty-nine men marooned on the work. The superstructure of the inner station was swept away, but the machinery was saved. Two pile-drivers disappeared, together with twenty-one flat cars, with unloader and plow.

Considerable damage was done by the same storm to the completed west breakwater, and to the mole at Cristobal piers; to save the latter a force of seventy-five men worked four days dumping trainloads of rock on the sea side.

Conference of Building Commissioners and Inspectors Called

In response to a widespread demand, a committee has decided to call a conference of building commissioners and inspectors to be held on Friday, May 14, 1915, at the Hotel Astor, New York. This time and place have been chosen because of the annual meeting of the National Fire Protection Association, which is to be held on May 11, 12, and 13 at the same place. The questions which this conference will discuss include:

1. Technical details of fire protection, sanitation, and structural safety.
2. Questions of administration-relation between State and city authorities, methods of field inspection, rigid rules vs. discretionary power, etc.
3. Educational methods which the building inspector can use to gain the support of civic bodies and individuals, and to secure a better understanding by citizens generally regarding fire prevention and sanitation.

The conference will take the form of a round table discussion. The committee, whose names follow, will be very glad to receive suggestions as to how this conference may be made most valuable: R. P. Miller, engineer for building committee, Board of Aldermen, and former superintendent of buildings, New York; V. D. Allen, commissioner of buildings, Cleveland; James G. Houghton, inspector of buildings, Minneapolis; S. A. Dies, superintendent of building inspection, Pittsburgh; N. A. McIver, inspector of buildings, Edmonton, Alberta, Can., and Sidney J. Williams, State building inspector, Madison, Wis., secretary.

Advise Taking Kinks Out of the Chicago River

Straightening of the south branch of the Chicago River was advocated in a preliminary report submitted March 29 by the Chicago Railway Terminal Commission to the railway terminal committee of the City Council.

The report said the expense of straightening the river would be about $1,000,000. This would transfer about 18 acres of ground from the west to the east side of the river and create more than 4 acres of additional ground. According to John F. Wallace, the consent of practically all the railroads, which own most of the property, has been obtained. In addition to creating 4 acres of land, the plan will enhance the value of other land.

Bion J. Arnold, a member of the commission, said the commission's work had shown that the railroads are more willing now to treat with the city than for several years. He said railroad heads were seriously considering the question of through-routing of suburban traffic, something they frowned on when first suggested.

Amendment to Eight-Hour Labor Law Vetoed

Governor Lister of Washington recently vetoed a bill to amend the public-works law, so as to permit a ten-hour day on State highway work. Expressing himself as being personally of the opinion that the eight-hour law should be kept on the statute books in its entirety, the Governor stated, in explaining his veto, that if part of the law were repealed it would be unfair not to repeal the whole.

Present Status of New York Building Code Revision

The long-delayed revision of New York's building code is rapidly progressing toward completion. Over a year ago R. P. Miller was appointed engineer for the aldermanic committee, and under his direction revision has been made article by article, with the object of introducing each article as a separate ordinance. Tentative drafts of the revised sections were first published, suggestions and comment invited, the amended article introduced in the Board of Aldermen as an ordinance, a public hearing held, and finally the ordinance was either passed or recommitted.

At the present time the articles which have been revised, introduced as ordinances and passed, are those referring to restricted areas (fire limits and suburban limits), partition walls and fences, and to plumbing. Those which have been revised and introduced as ordinances are: elevators, which was recommitted, materials, wood construction, iron and steel construction, and working stresses and loads. A hearing was held on April 1 on iron and steel, and on wood construction; and a hearing is called for April 8 on working stresses and loads.

The articles on light and ventilation, exit facilities, excavations and foundations, classification of buildings, and reinforced concrete have been tentatively revised, but not yet introduced as ordinances.

Joint Highway Congress to Be Held in San Francisco

Last December representatives were appointed by the American Highway Association and the American Road Builder's Association to confer and formulate plans for holding a joint road congress in San Francisco at about the time of the International Engineering Congress. Two representatives were appointed by each body, James H. Macdonald, of New Haven, Conn., and J. E. Pennybacker, of Washington, D. C., representing the highway association, and W. W. Crosby, of Baltimore, and E. L. Powers, of New York, the road builders.

The joint committee had several meetings and finally agreed to invite Governor C. W. Gates, of Vermont, formerly highway commissioner of that State, to become the fifth member of the committee. Governor Gates has accepted and was elected chairman of the body, which now becomes the governing board in charge of all arrangements for the congress.

It has been determined to hold the meeting in San Francisco, Sept. 6 to 11, inclusive, this being the second week preceding the International Engineering Congress and the one immediately before the meeting of the American Society of Civil Engineers and a number of other national engineering bodies.

Waterworks Directory Ready May 1

The McGraw Waterworks Directory will be ready for delivery May 1. It contains information of the populations of cities and towns; municipal and privately owned waterworks systems, including the names of executive and operating officials; sources of water supply; distribution systems, with detailed data in regard to reservoirs, standpipes, elevated tanks, pipe, valves, hydrants, meters, pressures and the quantity and the make of various items of equipment; purification systems; boiler plant and pumping equipment; rates, and other data necessary to make such a directory of the utmost value to its readers.

All of this information has been obtained direct from the engineers or superintendents in charge of the individual plants and is of a kind that should be invaluable to manufacturers, engineers, chemists, contractors, investors and all others interested in American waterworks plants. The price of the book is $15, delivered. Orders should be addressed to the McGraw Publishing Company, Inc., 239 West 39th St., New York.

Arrangements Made for 1915 International Engineering Congress

Information has been given out as to transportation, headquarters and other arrangements that have been made for the International Engineering Congress, which will be held in San Francisco, Sept. 20-25.

The headquarters of the American Society of Civil Engineers, and of the American Institute of Electrical Engineers respectively will be at the St. Francis Hotel. The American Society of Mechanical Engineers will be at the Clift Hotel, and the American Institute of Mining Engineers, at the Bellevue. The special train from New York will leave the Grand Central Terminal Sept. 9 at 7:45 p. m., and will arrive in San Francisco at 9 p. m., Sept. 15, stopping at Niagara Falls and the Grand Canyon. Arrangements for as many cars as may be necessary have been arranged for on the Sunset Limited to accommodate those traveling from New Orleans. The train will leave that city at 11 a. m., Sept. 12, and will arrive at San Francisco at 1 p. m., Sept. 15. Details as to the time of arrival of these trains at intermediate points may be had by addressing any of the societies or the secretary of the International Engineering Congress.

News of Engineering Societies

The Engineers' Club of Philadelphia will hold a meeting April 3. A. Merritt Taylor will speak on "Philadelphia's Transit Problem."

The Engineers' Club of St. Louis at a meeting held in that city March 31 heard Walter A. Heimbuecher, city engineer of University City, Mo., speak on "Typical Engineering Problems of Missouri Municipalities."

The Western Society of Civil Engineers held a meeting in Chicago March 29. Asa C. Baldwin, chief of the American party on the Alaskan boundary survey, spoke on that work. The paper was illustrated by lantern slides. At the next meeting of this society, April 5, Col. W. V. Judson, Corps of Engineers, U. S. A., will speak on "Engineering in War."

The Toledo Society of Engineers held a meeting in that city March 26. Prof. W. C. Hoad, of the University of Michigan, spoke on "Recent Developments in Sewage Disposal." The next meeting of the society will be held April 16. Prof. H. E. Riggs, member of the American Society of Civil Engineers Valuation Committee, will speak on "Special Problems in Valuations."

The Cornell Society of Civil Engineers held its regular spring meeting at the Cornell Club, 65 Park Avenue, New York City, March 25. There was an informal dinner and, afterwards, James B. French, consulting engineer, gave an account of the last meeting of the American Society of Civil Engineers and explained the suggestions made by the committee which will represent that society at the State constitutional convention to be held this month. Other speakers were: C. L. Barton, of the McHarg-Barton Company; John A. Knighton, of the Department of Bridges, New York City; Joseph C. Hilton, of Mason & Hilton, contractors; Weston Fuller and Howard E. Hyde. A. B. Lueder gave an account of conditions in Chili.

The Engineers' Society of Pennsylvania celebrated its eleventh anniversary with a banquet at the Harrisburg Club in Harrisburg, March 27. Those who spoke were: Prof. D. C. Jackson, of the Massachusetts Institute of Technology; Prof. J. P. Moyer, Pennsylvania State College; Prof. J. H. Harris, Bucknell University; Chancellor McCormick, of the University of Pittsburgh; Director A. A. Hammerschlag, of the Carnegie Institute of Technology; T. L. Montgomery, State Librarian of Pennsylvania; J. V. W. Reynders, vice-president of the Pennsylvania Steel Company; Dr. McIntyre, of Dickinson College, and W. A. Granville, president of Pennsylvania College. The importance of broad knowledge and wide vision to the engineer was the keynote of the addresses. Emphasis was placed upon the relation of the engineer to industrial problems and political conditions.

Personal Notes

John A. Jones has been reappointed city engineer of Lewiston, Maine.

Tyler W. Earle was recently named as superintendent of streets of Rutland, Vt.

William Steckleberg, of Lincoln, has been appointed assistant State engineer of Nebraska.

A. B. Lueder, in charge of construction of harbor improvements in Chili for the Snare & Triest Company, of New York, has recently returned to the United States.

D. D. Price has resigned from the office of State engineer of Nebraska. He was appointed to the office in 1911, after having served two years as assistant State engineer.

George E. Johnson has been appointed State engineer of Nebraska, succeeding D. D. Price, resigned. For the past five years Mr. Johnson has been city engineer of Falls City, Neb.

A. C. Grover has been appointed city engineer of Rutland, Vt. Mr. Grover, as noted in these columns, March 20, was recently elected president of the Vermont Society of Engineers.

Robert L. Faris has been appointed assistant superintendent of the the U. S. Coast and Geodetic Survey, succeeding F. W. Perkins, whose resignation was announced in these columns March 20.

Fremont Morse will have temporary charge of the exhibit of the U. S. Coast and Geodetic Survey at the Panama-Pacific Exposition pending the arrival of E. F. Dickens, who has been assigned to relieve W. E. Parker in that office.

George A. Johnson, consulting engineer, of 150 Nassau St., New York, has been retained by the city of Cambridge, Mass., to design and supervise the construction of a filtration plant that is expected to cost between $250,000 and $300,000.

H. P. Warren, an engineer representing the Alaskan Railway Commission, has reached the Canal Zone, Panama, for the purpose of selecting canal machinery which may be used in the construction of the proposed government railroad in Alaska.

W. E. Parker, who has been in charge of the U. S. Coast and Geodetic Survey's exhibit at the Panama-Pacific Exposition, has been detached from this service and ordered to Washington for duty relating to the preparation of plans for new vessels.

Charles C. Yates has been designated as assistant inspector of hydrography and topography of the U. S. Coast and Geodetic Survey. Mr. Yates was graduated from the Case School of Applied Science in 1890 and entered the Government service in 1892.

Lewis Nixon, consulting engineer and acting commissioner of public works of the Borough of Richmond, New York, has tendered his resignation, for the purpose of devoting himself to his private interests. He was appointed to his position with the borough president in January, 1914.

L. B. Wickersham, assistant engineer of the Spokane, Portland & Seattle Railway, has resigned to engage in a general engineering practice in Portland, Ore. Previous to his connection with the company from which he has resigned Mr. Wickersham was chief engineer for the Oregon Electric Railway Company.

Brig.-Gen. William L. Sibert, U. S. A., who has been stationed at Cincinnati, has been transferred from the United States engineering district there to command of the Pacific Coast artillery district, with headquarters at Fort Miley, in San Francisco, Cal. He will leave Cincinnati on April 10 for San Francisco. General Sibert has recently been in charge of work on the deepening of the Ohio River, from Pittsburgh to Cairo.

J. S. Garland has been appointed to succeed W. A. McFarland, whose death was noted in this journal March 27, as superintendent of the water department of the District of Columbia. Mr. Garland has been in the service of this department since 1893. Previous to this promotion he was first assistant to the superintendent and was closely associated with him in the design and construction of Washington's present waterworks system.

Alexander P. Gest has been appointed secretary of the Association of Transportation Officers of the Pennsylvania Railroad East of Pittsburgh. Mr. Gest was graduated from the Rensselaer Polytechnic Institute in 1874 with a degree in civil engineering. He entered the service of the Pennsylvania in 1875. In 1882 he was appointed supervisor, at Huntingdon, Pa., and a year later was promoted to division engineer of the Monongahela Division. In 1889 he attained the grade of superintendent, and, later, was appointed special agent of the New Jersey Division.

Obituary Notes

Chapin F. Phillips, superintendent of erection of the Detroit Steel Products Company and a resident of Chicago for more than 30 years, died in that city March 21.

John C. Breedlove died in St. Paul, Minn., March 10. He was an assistant engineer of the Northern Pacific Railroad and had been engaged in engineering work since 1901.

W. B. McLoughlin, engineer of maintenance of way of the Cleveland, Cincinnati, Chicago & St. Louis Railway, died in Cincinnati, March 15. His death was due to injuries sustained in a motor car accident near Lawrenceburg Junction, Ind., three days earlier.

Foster Crowell, consulting engineer of the Borough of Queens, died in New York City, March 29. He began his engineering career in 1867 and became well known for his work in railroad location, construction and economics, and in hydraulic engineering. He took a prominent part in the early explorations for the Nicaragua Canal and was for some time engineer of construction with the Pennsylvania Railroad. Previous to his first appointment as consulting engineer of Richmond Borough in 1912, he was established at 18 Broadway, New York, as a consulting engineer. He was commissioner of street cleaning of New York under Mayor McClellan. He was the author of several books, including "The Training of a Tropic Current," "Railroad Facilities of Suburban New York," "Modern Wharves and Harbors" and "How Holland Was Made."

Civil Service Examinations

Springfield, Ill.—The Illinois Public Utilities Commission will hold an examination on May 1 for two positions of utilities investigators, salary $100 to $150 per month, open only to men over 21 years of age and residents of Illinois. The work deals with the collection of data regarding railroad accidents, investigation of crossings over railroads and the performance of other engineering and investigating work for the commission.

Examinations Previously Announced

Date		See Eng. Record
April 28–29	Surveyor - draftsman, U. S. Government service; salary $1200-$1500	Mar. 20
April 14	Civil engineer and draftsman, copyist draftsman, ship draftsman, Navy Department; mechanical draftsman, topographic draftsman, Panama Canal service; engineer, Indian service; United States....	Feb. 6